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Report

Ground Water Interim Remedial Action Workplan

Bishop Tube Site
Frazer, Pennsylvania

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Contents

Tables

Figures

Appendices

1. Introduction

1.1. Purpose

O'Brien & Gere Engineers, Inc. has prepared this Ground Water Interim Remedial Action Workplan for the Bishop Tube Site (Site). The Interim Remedial Action Workplan (IRAW) details the field activities, sampling, remedial design, permitting and reporting tasks in accordance with the *Site Characterization/Interim Remedial Action Plan (SC/IRAP) Report* (O'Brien & Gere, September, 1998). The *SC/IRAP Report* was submitted to and reviewed by the Pennsylvania Department of Environmental Protection (PADEP). The recommendations provided by the PADEP in their November 3, 1998 comment letter were considered in the completion of this Workplan.

1.2. Project background

The Site is located in Frazer, Chester County, Pennsylvania (Figure 1) and is approximately 13.7 acres in size. The facility is used in the production of stainless steel tubing for a variety of industrial uses and has been utilized for the manufacture of tubing and related products almost continuously since the 1950's.

Based on the site characterization of volatile organic compound (VOC) impact to ground water, surface water and soil, an interim remedial action program (Interim RAP) for ground water is being implemented to address the VOC concentrations in ground water. The Interim RAP is outlined in the *SC/IRAP Report*. To expedite implementation, the interim remedial action activities incorporate key data gathering and interim final design tasks, many based on actual remedial performance, to eliminate the need for further site characterization programs prior to initiating remedial action implementation.

Hydraulic containment via ground water extraction (pumping) and treatment was selected as the interim remedial technology for this Site based upon the nature and extent of ground water impact, and the availability and practicality of implementation of remedial technologies in this type of geologic formation.

The interim ground water containment system will consist of pumping ground water initially from the source area and areas of highest ground water VOC concentrations with sufficient extraction points to create a zone of hydraulic control. Ground water extraction will also be utilized to create hydraulic control between the Site area and the adjacent stream to mitigate VOC discharge to this surface water feature. Initially, and for the purposes of pilot testing, ground water will be collected through submersible pumps placed in vertical wells. The extracted ground water will be passed through a treatment system to remove the VOCs to meet discharge limits, with the current plan to discharge to the adjacent sanitary sewer system (with approval from East Whiteland Township/Valley Forge Sewer Authority). It is assumed that for the longer term ground water extraction, the treated ground water would continue to be discharged to the local sanitary sewer, if these approvals can be obtained.

The *SC/IRAP Report* provides additional background regarding the technical approach to ground water remediation, as well as the hydrogeologic characterization of the Site.

1.3. Objectives of ground water Interim RAP

The remedial action objectives of the ground water Interim RAP include: 1) mitigation of further off-site migration of impacted ground water; and 2) the reduction of the concentrations of VOCs in the ground water to levels considered achievable in the given subsurface environment with available and proven technology. The long-term goal will be to achieve compliance with the Pennsylvania Land Recycling and Environmental Remediation Standards Act (Act 2) regulations. After successful implementation of the ground water extraction/hydraulic containment system and a sufficient performance evaluation/startup period, it is anticipated that the entrance of the Site into the Act 2 program will be pursued.

2. Interim final design activities

The *SC/IRAP Report* outlined the interim final design activities for the Interim RAP and these activities are summarized below.

2.1. IRAW development

This IRAW was prepared based on the PADEP-reviewed *SC/IRAP Report*. The remaining sections of this IRAW detail the activities for implementing the Site interim ground water source control/hydraulic containment system.

The IRAW provides the basis for field and sampling activities, and includes:

- Interim final design activities (remaining Section 2 subsections);
- Residential wellhead treatment system (RWTS) installation and operation and maintenance (Section 3);
- Pilot testing activities and data evaluation, and final interim system design and startup (Section 4);
- Operation, maintenance and monitoring of the hydraulic containment and treatment system (Section 5); and,
- Sampling and Analysis Plan for the Interim RAP, including the Field Sampling Plan (Section 6) and Quality Assurance Project Plan (Appendix A).
- Site-specific Health and Safety Plan (HASP) (Appendix B) for interim remedial activities. The HASP was developed for O'Brien & Gere personnel only. Health and safety monitoring will be conducted independently by remedial contractor(s) working at the Site and O'Brien & Gere in accordance with their individual Health & Safety Plans. The HASP identifies, at a minimum, health and safety personnel, protection levels, proposed remedial activities and emergency response procedures.

- Implementation plan and updated Interim RAP implementation schedule (Section 7).
- References (Section 8).

2.2. Pilot test design/permitting

The pilot test for the hydraulic containment system and ground water treatment system was designed and permitting/discharge authorization issues for the discharge of treated ground water were evaluated. The pilot testing approach, procedures and equipment are presented in Section 4. Additional monitoring/extraction wells and piezometers, which will be utilized in the pilot testing, will be installed as part of interim final design activities as detailed below.

The ground water treatment system for the hydraulic containment system pilot test will require a treated water discharge authorization. No air discharge (equipment installation/operation) permit is considered necessary for the pilot test since liquid-phase activated carbon beds are planned to remove the VOCs from the extracted ground water prior to discharge (instead of air stripping as currently planned for the long-term system).

Three basic options were considered for discharge of the treated ground water during the pilot test:

1) discharge to the local sanitary sewer, with approval from East Whiteland Township/Valley Forge Sewer Authority;

2) discharge to the adjacent stream, which would require an NPDES discharge permit; and,

3) re-injection of ground water, which would also require an NPDES discharge/re-injection permit.

Given the planned duration of the pilot test (approximately one week), option 1 was considered the most feasible. Off-site disposal was not considered feasible, given the anticipated flowrate of 60 gpm (86,400 gpd) for extracted ground water during the pilot test.

Preliminary discussions with the Valley Forge Sewer Authority (VFSA) and East Whiteland Township indicated a limited approval may be granted for this activity based on certain restrictions if the VFSA water quality discharge criteria are met. These restrictions will likely include limitations on the flowrate and/or certain hours when discharge can take place. Based on the treatment technology planned for the pilot test (activated carbon beds in series - see Section 4), attainment of the VFSA effluent discharge criteria will not be an issue. Discussions with the VFSA/East Whiteland Township have been initiated in an effort to secure this discharge approval for the pilot test activities.

2.3. Hydraulic monitoring

Hydraulic monitoring for the Site is being conducted to establish seasonal or man-made influences on ground water flow. Hydraulic monitoring was initiated in January 1999 and will continue on a monthly basis through the year. Each monitoring event consists of collecting a synoptic round of depth to ground water measurements from the existing monitoring wells (on-site and off-site). The depth to ground water measurements will be used to calculate ground water potentiometric evaluations and to assess hydraulic gradients and flow direction.

During the January 1999 hydraulic monitoring event and the February 1999 baseline ground water sampling event (as discussed in Section 2.4 below), further attempts were made to locate monitoring well MW-10 including using a scaled drawing and a metal detector. As this well has not been located to date, it has not been included in the hydraulic monitoring for the Site. If monitoring well MW-10 is located in future, it will be included in the hydraulic monitoring activities.

2.4. Baseline ground water sampling event

A baseline ground water sampling event was completed during February 16-19, 1999 and consisted of collection of ground water samples from Site monitoring wells. The baseline ground water sampling event was completed to provide updated ground water quality information and to provide additional ground water chemistry parameters to be used in the design of the treatment system and permitting efforts.

The baseline ground water sampling activities were conducted in accordance with the PADEP *Ground Water Monitoring Guidance Document* (February 1996) and QAPP included herein (Appendix A). Nineteen monitoring wells were utilized for ground water sampling during the baseline sampling event. This includes existing monitoring wells MW-1 through MW-20, with the exception of monitoring well MW-10 (which has not been relocated).

A cleaned submersible pump attached to a length of dedicated, Teflon®-lined polyethylene discharge hose was used to purge ground water from the monitoring wells prior to sampling. The purge water was contained in temporary, polyethylene holding tanks and transferred to an on-site Baker® tank. Approximately 2,482 gallons of purged ground water and decontamination fluids were generated during the baseline ground water sampling event. Ground water samples were collected directly from Teflon®-lined discharge hose. Samples for dissolved metals were field filtered using a 0.45 micron filter. Quality assurance/quality control (QA/QC) samples were collected during the baseline ground water sampling event in accordance with the QAPP.

The ground water and QA/QC samples were submitted to a PADEP-certified laboratory (STL-Envirotech) for analysis. The samples were analyzed for the compounds of concern in ground water - VOCs, fluoride and select metals as follows:

- Priority Pollutant List (PPL) VOCs by EPA Method 8260
- Dissolved fluoride by EPA Method 340.2
- Dissolved chromium, copper, nickel, and zinc by EPA Method 6010

QA/QC samples were collected and analyzed, including 3 trip blanks (VOC analysis only), 1 field rinsate (equipment) blank, 1 set of matrix spike/matrix spike duplicate samples (2 samples), and 1 duplicate (ground water duplicate).

In addition to the 19 ground water samples and associated QA/QC samples, ground water samples were collected from monitoring wells MW-2 and MW-9 and submitted for the following analysis to provide additional ground water chemistry data for the treatment system design:

- Total suspended solids (TSS), total dissolved solids (TDS)

- Total organic carbon (TOC), total organic halides (TOX)
- Chemical oxygen demand (COD), biological oxygen demand (BOD)
- pH
- Total iron, calcium and magnesium
- Dissolved iron
- Total and phenolphthalein alkalinity.

A sample of the staged purge/decon water was collected on February 26, 1999 for characterization purposes. Based on characterization results, the approximately 2,482 gallons of water were transported off-site for treatment and disposal at a permitted facility (E.I. DuPont De Nemours & Co., Deepwater, New Jersey).

The laboratory analytical result/data packages for the baseline sampling event were received in April 1999 and are currently undergoing validation in accordance with the QAPP. The field and laboratory data associated with the baseline ground water sampling event will be compiled and reviewed following data validation. The ground water data and field sampling logs will be provided to the PADEP after validation by the end of May 1999 and will be included in the next Progress Report (outlined in Section 4 herein).

2.5. Residential well water sampling

To provide ground water chemistry information to design the residential wellhead treatment system (RWTS), a ground water sample was collected from the private residential well located at 54 Conestoga Road on February 24, 1999. Prior to mobilization, the resident/owner was contacted and O'Brien & Gere was granted access for sampling activities by the resident/well owner. The kitchen sink faucet, located near the well, was used as the sampling point. The faucet was turned on and the water was allowed to run for approximately 20 minutes prior to sample collection consistent with current PADEP guidance. The sample was collected directly from the faucet into clean, laboratory-supplied containers. The sample containers were labeled, placed in an ice-filled cooler, and sent via courier

The water sample was submitted for analysis of the following system design/treatment parameters:

- TSS
- TDS
- Total plate count
- Iron
- Manganese
- Hardness
- TOC
- pH

2.6. Residential wellhead treatment system design

Based on the results of the residential well water sampling for remedial design parameters, the design of the residential wellhead treatment system (RWTS) was completed. The RWTS design, installation, and operation, maintenance and monitoring plan are detailed in Section 3 below.

2.7. Well installation plan

2.7.1. Well/piezometer locations

Hydraulic containment and source control will be initially implemented through ground water extraction/hydraulic control in the on-site area proximal to the MW-2/MW-3 and MW-8/MW-9 well clusters. For this purpose, additional monitoring and extraction wells will be installed as part of interim remedial design activities. Based on the VOC distribution and occurrence of water producing zones reported, source control will be phased-in, starting with extraction wells pumping from the overburden and uppermost 100 ft bedrock aquifer zone. The use of vertically separated extraction zones is necessary to minimize the potential downward movement of higher VOC concentrations in ground water from the overburden/upper bedrock ground water zones to lower bedrock ground water zones.

In the former degreaser MW-2/MW-3 source area, ground water producing zones in the uppermost 100 ft were identified that can be grouped within three vertical zones:

- the shallow overburden zone and upper 10 to 20 ft of bedrock (to 375 to 365 ft msl), penetrated by wells MW-3 and MW-2, respectively.

- the zone between elevations 350 ft and 330 ft above mean sea level (msl), with water yielding fractures reported in this zone during drilling of MW-19, MW-9, MW-13, MW-18, MW-15 and MW-17, with potential yields of 20 to 30 gallons per minute (gpm). This is the zone currently monitored by MW-9, MW-13 and MW-18.

- the zone at or near approximately 300 ft msl with reported water bearing fractures during drilling of MW-19 and MW-15. MW-15 currently monitors this zone and the elevation data from MW-15 suggest that ground water may have an upward flow component. An initial yield estimate for this zone is 5 to 10 gpm.

The *SC/IRAP Report* presents vertical cross-sections and monitoring well screening intervals, as well as boring/construction logs for Site monitoring wells.

Pilot testing will include ground water extraction from MW-2 and MW-3 in the shallow overburden and overburden-bedrock interface. A ground water extraction well will also be installed in the MW-2/MW-3 area to recover ground water from the zone at elevations 350 to 330 ft msl (approximately 35 to 55 ft below grade (bg)) and assess hydraulic control in the upper bedrock aquifer. In addition, an open-hole monitoring well, which may also serve as a future extraction point, will be installed in this area and will monitor a vertical interval including the zone from approximately 310 to 290 ft msl (approximately 75 to 95 ft bg), to provide ground water quality and hydraulic data. The well installation and construction procedures are described below.

In addition to ground water extraction in the area north of the plant (MW-2/MW-3/MW-19 area), ground water extraction will be implemented in the area to the east/northeast of the plant and assumed upgradient area of the stream. Wells MW-8 (overburden) and MW-9 (bedrock) will be used as extraction wells for pilot testing and to assess hydraulic containment of the higher VOC concentrations in the MW-8/MW-9 area.

The hydraulic relationship between the stream (Little Valley Creek) and the overburden/bedrock ground water zones in this area will be evaluated through the installation of 2 piezometers and hydraulic/quality monitoring. The piezometers will also provide hydraulic data during ground water extraction pilot testing. Piezometer installation procedures are described in Section 2.8 below.

2.7.2. Well installation and construction

MW-21

Monitoring well MW-21 will be installed adjacent to the MW-2/MW-3/MW-19 locations, as depicted in Figure 2. This monitoring well will be used initially for monitoring purposes and for hydraulic pilot testing of ground water extraction. It is anticipated that this well will also be used for longer term hydraulic containment as discussed above. This monitoring well will be constructed as a 6-inch diameter, open borehole design, and will be double-cased in an effort to prevent vertical cross-contamination during drilling and well installation. As presented above, the MW-21 open-hole interval will be from approximately 350 to 330 ft msl (35 to 55 ft bg).

Drilling procedures are outlined in the Sampling & Analysis Plan (Section 6 herein) and will consist of hollow stem auger (HSA) and/or standard mud rotary/air rotary and other standard drilling techniques. To reduce the potential for possible cross contamination and to accommodate various geologic sampling methods which may be needed to fully characterize geologic conditions in this borehole, multiple casings will be advanced. A 10-inch diameter casing will be installed 5 ft into rock (18 ft bg). A second casing, 6-inches in diameter, will be installed to approximately 35 ft bg (elevation 350 ft msl). Each casing will be properly sealed prior to continued borehole advancement, with an appropriate time period (minimum 12 hours) during which the borehole is undisturbed and grout is allowed to cure. The monitoring well will be constructed with 6-inch diameter open-hole design with a 20 ft open interval at a depth expected not to exceed 55 ft below grade within the upper bedrock zone. Geologic sampling is expected to include split-spoon sampling, rock-coring, and drill cuttings inspection. Samples will be field screened with a photoionization detector (PID) for the presence of volatile compounds. In addition, ultraviolet (UV) fluorescence will be used to screen for potential residual product (non-aqueous phase). Select saturated soil samples may be collected (based on field screening) for laboratory analysis following USEPA Method 8260 for VOCs.

Following completion of MW-21, the well will be developed with a submersible pump and surging. Development water will be managed in accordance with the Sampling & Analysis Plan (Section 6). A grab ground water sample will be collected for VOC analysis after development. Subsequently, the well will be surveyed for horizontal and vertical control by a licensed surveyor.

MW-22

Monitoring well MW-22 will be installed proximal to the MW-21 location as shown in Figure 2. This monitoring well will be used for monitoring purposes, and will be considered for use as an extraction point in the future for the hydraulic containment system. This monitoring well will be constructed as a 6-inch diameter, open borehole design and will be double-cased in an effort to prevent vertical cross-contamination during drilling. As presented above, the MW-22 open interval will include the zone from approximately 310 to 230 ft msl (approximately 75 to 95 ft bg).

Drilling procedures, development and surveying will be conducted as described for MW-21 above and in accordance with the Field Sampling Plan. A 10-inch diameter casing will be installed 5 ft into bedrock (18 ft bg), followed by a second, 6-inch diameter casing to 70 ft bg. The well borehole will be then advanced until a water producing zone of 5 to 10 gpm is encountered, or to a maximum depth of 95 ft bg (elevation 290 ft msl).

During installation of MW-21, should significant VOC levels be encountered in the 18 to 55 ft bg zone (*i.e.* TCE or other VOC concentrations at percentages of aqueous solubilities or visual identification of a non-aqueous phase), the MW-22 construction will be modified. In this case, the well will be triple-cased. The diameter of the first two casings will be enlarged to diameter of 14-inches and 10-inches. The 10-inch diameter casing will be installed to case off this impacted zone and will be adjusted based on the occurrence of the significant VOC impact zone. A third casing, 6-inches diameter, will be installed to a depth of 70 ft bg. The well will then be completed as above.

2.8. Stream assessment

As described in the 1998 *SC/IRAP Report*, the ground water - stream hydraulic relationship and stream quality will be investigated. The results of this investigation will be used to further assess the surface water quality of the Little Valley Creek and advance the design of the planned ground water - stream hydraulic cutoff system.

2.8.1. Surface water sampling

Previously, VOCs were detected in surface water samples collected from the Little Valley Creek adjacent to the Site (Stream-1 and Stream-2 locations, depicted in Figure 3). Surface water samples will be collected from the stream at these points and Stream-3 point and analyzed for VOCs (EPA Method 8260B), the metals chromium, copper, nickel and zinc (EPA Methods 6010) and fluoride (EPA Method 340.2). Surface water sampling procedures are described in the Sampling & Analysis Plan (Section 6).

2.8.2. Piezometer installation

To assist in the assessment of the ground water - stream hydraulics, two piezometers will be installed in the vicinity of MW-8/MW-9 and hydraulically upgradient of the stream. Each piezometer will be constructed of 2-inch diameter PVC screen and riser, with a maximum screen length of 5 ft. One piezometer (PZ-1, Figure 2) will be installed in the overburden zone, with the screen bottom at the overburden/bedrock interface, to a depth of approximately 26 ft bg. The second piezometer will be installed in the uppermost bedrock zone, with the screen bottom at an estimated 36 ft bg. For the bedrock piezometer, 6-inch diameter casing will be installed 3 ft into bedrock and grouted. The grout will be allowed to cure a minimum of 12 hours prior to advancing the borehole further. Piezometer installation procedures are detailed in the Sampling and Analysis Plan. After completion, the piezometers will be developed and surveyed for horizontal/vertical control by a licensed surveyor.

The piezometers will be incorporated in the monthly ground water elevation monitoring schedule and the hydraulic pilot testing phase.

2.8.3. Ground water/surface water sampling

After the completion of the two piezometers, ground water samples will be collected from the piezometers, new monitoring wells (MW-21 and MW-22) and two existing monitoring wells (MW-8 and MW-9), and surface water samples will be collected from the stream. The water samples will be analyzed for VOCs, select metals and fluoride as above. In addition, ground water samples (except MW-21 and MW-22) and additional surface water samples will be analyzed for indicator parameters to compare ground water and surface water constituents and further assess the ground water - stream relationship. These parameters are:

- pH (field)
- Redox potential (Eh) (field)
- temperature (field)
- conductivity (field)
- dissolved oxygen (field)
- turbidity (field)
- total dissolved solids (TDS)
- anions/cations
- total organic carbon (TOC)

Ground water and surface water sampling procedures are provided in the Sampling & Analysis Plan (Section 6).

2.8.4. Stream level gauging

The surface water sampling points and stream level monitoring points will be re-established using surveyed horizontal coordinates and a professional (PA-licensed) surveyor. Stream level reference points will be established and surveyed for vertical control. Semi-permanent stakes or sounding rods with marked reference points will be established at each point. Surface water levels will be measured relative to these reference points on a monthly basis and during the hydraulic pilot testing phase.

2.9. Data evaluation

The data generated by the interim final design task will be compiled and evaluated to update the characterization of ground water conditions. Data compilation activities will include field forms, field notes, summary data tables and laboratory analytical reports. Laboratory analytical data will be data validated as discussed in the QAPP (Appendix A) of the Sampling &

Analysis Plan. Once validated, the analytical data will be compiled into the Site database along with other descriptive Site and sample location data.

Particular data evaluation objectives for the interim final design activities are:

- Further evaluate the VOC concentration distribution in ground water, particularly in the vertical zones proximal to MW-2/MW-3 source area and the MW-8/MW-9 and stream area.

- Further evaluate the hydraulic gradients beneath the Site in these areas and the ground water - surface water relationships, in terms of water flow and quality.

- Provide the design data for the RWTS installation (Section 3).

- Provide additional data for implementation of the pilot test (Section 4).

The results of data evaluation activities will be provided in the next Progress Report (noted in Section 4 herein).

3. RWTS installation, operation and maintenance

3.1. Site inspection and residential well sampling

A site inspection of the 54 Conestoga Road residence was conducted on February 24, 1999 by O'Brien & Gere to identify site specific requirements for the installation of a RWTS and to collect a water sample to characterize general water quality parameters to assist in the design of the RWTS (Section 2). The existing water supply system at the residence consists of a submersible well pump, well transmission piping and bladder-type pressure tank located in the basement of the dwelling.

General water quality characteristics for the influent to the RWTS are listed in Table 1.

3.2. Installation of residential well treatment system (RWTS)

A RWTS was installed at the 54 Conestoga Road residence on March 31, 1999 and began operating to remove the VOCs previously detected at this location.

The RWTS unit included the primary components listed below:

- sediment filter
- pressure gauge/valves
- sample valves
- granulated activated carbon (GAC) units, two units in series
- ultraviolet (UV) light sterilization/disinfection unit.

The GAC was included to remove identified VOCs from the influent water. The UV unit was provided to disinfect effluent from the GAC units if bacterial growth occurs within the GAC units. A schematic diagram of the RWTS is presented in Figure 3.

3.3. RWTS operation and maintenance

The RWTS was designed to require low maintenance. However, to provide a preventive maintenance program, the following activities will be conducted during the first year operation of the treatment system. As provided for below, quarterly site visits are proposed for the first year of operation. It is anticipated that this frequency can be reduced after the first year of system operation is completed.

Quarterly site visits will be performed to inspect and service the treatment systems. The visits will be conducted by an experienced O&M contractor. The following services will be performed quarterly:

- Collect water sample from between the GAC units in series for VOC analysis by EPA Method 524.2 (a sample will also be collected from the end of the treatment system and archived for potential subsequent VOC analysis if deemed necessary based on results of the in-between sample). Based on the first sampling/inspection event conducted on April 8, 1999 (1 week after system installation), the VOC levels were non-detect for the in-between sample and the system is functioning as designed.

- Inspect the sediment filter and pressure gauges to check that the systems are in proper working condition; fix potential leaks in valves or piping; and flush or replace the sediment filter, as necessary.

- Inspect the ultraviolet (UV) disinfection unit, energize the unit or replace lamp as necessary; flush the system.

- Inspect the granular activated carbon (GAC) units for potential clogging and/or fouling, collect a water sample for VOC analysis from between the GAC units to assess changeout frequency, and flush the system as necessary.

- Document inspections and work done in an O&M log.

In addition, during the first quarterly inspection after installation and once per year thereafter, a water sample will also be collected from the effluent from UV units for total (standard) plate count and total coliform bacteria, to verify that a sufficient level of disinfection is achieved.

It is estimated that one GAC changeout will be conducted over the initial one-year O&M period. This is a reasonable assumption for changeout frequency given the level of TCE detected at this location in the past (0.053 ppm) and other trace VOC levels detected. Actual GAC changeout frequency may be modified based on the initial or quarterly VOC sampling results. Spent carbon canisters/sediment filters will be disposed by the property owner as household/municipal waste.

4. Pilot testing, final design and system startup

4.1. *Hydraulic containment/treatment pilot testing*

4.1.1. General

As outlined in Section 2 and in the *SC/IRAP Report*, a hydraulic containment/treatment system pilot test will be conducted to expedite and support the Interim RAP final design and implementation. Based on the pilot test results, the interim final design will be completed, including the installation of additional extraction wells or other ground water recovery structures (*e.g.* overburden trench) and the longer term water treatment system. Specifically, the objectives of the pilot test are to:

- identify the yield (sustainable pumping rate) and pumping hydraulic influence area of the existing overburden (MW-3, MW-8), shallow bedrock (MW-2, MW-9) and newly installed extraction well (MW-21)
- evaluate the hydraulic properties of the bedrock aquifer under continuous pumping, particularly the effects of secondary porosity (fractures/joints, bedding planes)
- further assess the nature of VOCs in ground water and pre-treatment VOC concentrations during pumping
- provide the basis for full scale implementation of the interim containment system, including the potential location of additional ground water extraction wells or other recovery structures and the treatment system.

4.1.2. Pilot testing plan

The recovery and treatment system described in the *SC/IRAP Report* is based on certain assumptions for ground water quality and flow rate. Prior to full-scale installation of the interim containment and treatment system, an approximately one week pilot test will be conducted to refine the basis of design parameters to further optimize final system performance. The pilot system will include multiple extraction points located within the MW-2/MW-3 source area and northeast plant/MW-9 area. The pilot system will be operated upon installation of the recovery well (MW-21, Section 2). The system will include submersible pumps and temporary piping connected to a 3,000 gallon equalization tank. Ground water will be pumped from the tank through two 5,000-gal liquid granular activated carbon (GAC) canisters connected in series. At this time, it is anticipated that the treated water will be sent to the Valley Forge Sewer Authority POTW during the pilot test period. Confirmation sampling for conformance with POTW standards during pilot test startup will consist of samples from a valve situated between the two carbon canisters, with an archived sample to be collected from a valve located after the second carbon canister which can be analyzed as needed.

Data collected during the pilot test will include the sustainable flow rate and total flow volume from each well, VOC and water quality data (influent/effluent) and ground water level measurements from the recovery wells, monitoring wells and piezometers. A summary of pilot test data to be collected is included in Table 2. The data will be used primarily to finalize the design/sizing for the permanent air stripper and off-gas treatment system. The data will also be used to support air and water discharge permitting for the permanent (long-term) system.

As described above, ground water will be extracted from the north plant area and east plant area as part of the interim containment system. The final number and locations of extraction wells will be evaluated based on initial pilot-testing and the phased-in implementation and actual performance data, rather than extended site characterization activities.

Two vertically spaced extraction zones will be pilot tested in the area proximal to MW-2/MW-3 and MW-9 wells with an estimated combined extraction rate of 30 to 60 gallons per minute (gpm). As noted above, extraction points will included MW-2, MW-3 and new well MW-21, and wells MW-8 and MW-9 for pilot testing of extraction from the overburden/shallow upper bedrock, within the upper 100 ft.

The ground water extraction wells will be equipped with instrumentation to continuously monitor flow and hydraulic head during pilot testing. The monitoring network will consist of existing and newly installed monitoring wells/piezometers. The hydraulic effects (i.e. capture zone), the mass of VOCs removed, and response of the VOC ground water concentrations to extraction will be evaluated through hydraulic monitoring and ground water sampling.

Prior to the initiation of pilot test pumping, ground water levels will be measured in Site wells/piezometers. Select wells will be outfitted with automated downhole transducers/data logging units to provide ground water level data for a period prior to pilot testing and during the pilot test.

The pilot test extraction wells (MW-2, MW-3, MW-8, MW-9 and MW-21) will be pumped periodically during the test based upon achievable yield and observed hydraulic response. Initially, MW-21 and MW-9 will be pumped and monitored to establish well yields, hydraulic influence and VOC concentrations under pumping. Second, the shallow overburden/upper bedrock wells (MW-2, MW-3 and MW-8) will be pumped and monitored. Depending on the hydraulic response of the shallow aquifer to deeper bedrock pumping, extraction from MW-9 and MW-21 may continue with overburden pumping.

During pumping, the flow rate and ground water levels will be monitored throughout the Site as outlined in Table 2. Ground water samples will be collected from the pilot test extraction wells, through the extraction pumps and in line sampling valves, and analyzed for VOCs and dissolved metals. With the exception of the purging procedures, ground water samples will be collected in accordance with the Sampling & Analysis Plan.

4.1.3. Remedial design progress report

Subsequent to the completion of pilot testing, a Remedial Design Progress Report will be prepared and submitted to PADEP. The following information will be documented within the Progress Report:

- reporting of well installation, ground water hydraulic and quality data, pilot testing and other Interim RAP activities, including data and evaluations accomplished during the reporting period;

- identification of deviations from or modifications to the IRAW, if required;

- reporting of issues or delays in the implementation with identified modifications and revised schedule;
- identification of the remedial action activities for the next reporting period;
- additional supporting documentation, as appropriate.

4.2. Final design

4.2.1. Hydraulic containment system

The *SC/IRAP Report* details the hydrogeologic setting of the Site, including anticipated influence of the geologic structure on ground water flow and the hydraulic containment system. This characterization will be updated based on the evaluation of pilot testing data. As part of the final interim design, the hydrogeological design will be completed to meet the objectives of the IRAP (Section 1). The hydraulic containment zone achievable with the ground water extraction wells will be estimated. Also, additional extraction points may be designed for hydraulic containment. The final design of the interim hydraulic containment system may include the use of ground water flow and fate and transport modeling, to further assess the longer term impact of ground water extraction.

The final design of the interim hydraulic containment system will include:

- number, location and type of ground water recovery points/structure
- estimated flow rates and VOC concentrations
- estimated zone of hydraulic containment (hydraulic capture)
- ground water flow interpretations, calculations and/or modeling results

Operations, maintenance (O&M) and monitoring of the hydraulic containment system will be addressed by the O&M Plan (Section 5 below)

4.2.2. Treatment system

The preliminary design of the proposed ground water treatment system was based on:

- projected ground water recovery rates;
- historic site ground water quality data, and

- hydraulic loading analysis and local (VFSA) sanitary sewer system discharge limits.

Based on these criteria, the remedial system will be designed to remove VOCs (primarily trichloroethene [TCE] and 1,1,1-trichloroethane [1,1,1-TCA]) from the ground water extracted at an average flow rate of 60 gpm with an influent VOC concentration of up to 400 ppm total VOCs. It is currently planned that treated water be discharged to the local POTW (Valley Forge Water Authority) through the on-site sanitary sewer system. Discussions with the VFSA (and East Whiteland Township) have been initiated towards assessing the viability of this option. No treatment for metals or other inorganics has been assumed based on available analytical data and the VFSA POTW discharge limits. The design parameters will be refined and finalized pending the results of the pilot test program.

<u>Influent Quality</u> - Historical ground water data collected from MW-3 and MW-9 were used to assess influent water quality to form the basis of the remedial approach since these wells are located in proposed extraction areas. Based on this profile, an aeration treatment unit was designed to treat an influent concentration of up to 400 ppm of total VOCs to applicable discharge limits. This system design and sizing were also based on the specific VOCs/levels present. Table 3 provides a flow-weighted average and maximum concentration for each VOC historically detected in MW-3 and MW-9. A summary of general water quality characteristics of on-site monitoring wells is presented in Table 4.

<u>Aeration Unit Conceptual Design and Layout</u> - Based on the hydraulic analysis and influent quality profile, the planned primary treatment process to remove VOCs from influent ground water will be forced-draft, counter-current air stripping. This air stripping unit will be a low-profile, shallow tray model sized to meet the discharge effluent criteria. The stripper will be located within the existing building. Ground water will enter the air stripper at the top and flow by gravity through a series of trays prior to a collection sump at the bottom of the unit as air is forced (induced) upwards through the trays by a blower. By forcing air through the water, dissolved VOCs will volatilize and be transferred from the water to the off-gas air stream. The air stripper will be sized to meet applicable effluent criteria and an operating flow rate (hydraulic loading) in the aeration unit of up to 150 to 175 gpm to allow for potential future expansion of the recovery well network, if required.

The VOC concentrations in the off-gas from the air stripper were estimated based on a 60 gpm flow rate and speciated mass average VOC concentrations for a preliminary evaluation of the need for off-gas controls and application for air permitting. The PADEP air quality regulations will require off-gas control based on the anticipated VOC removal rates.

For this system, a catalytic oxidizer equipped with a caustic scrubber has been included to treat the chlorinated VOCs in the off-gas. This equipment will also treat fugitive VOC emissions from the 3,000 gallon equalization tank after these emissions are collected in a negative pressure (induced air) hood system over the tank. The scrubber may be required to control the HCl formed during the breakdown of the chlorinated VOCs in the oxidizer. The design off-gas flow rate will be approximately 900 cfm.

A preliminary evaluation of inorganic ground water quality data indicate that levels of iron and manganese should not require pretreatment prior to discharge to the local POTW. A 3,000 gallon sedimentation/equalization tank and strainer have been assumed prior to the air stripping unit to equalize the influent flow rate and drop out/reduce potential settleable solids. The equalization tank will be equipped with a hood with induced air flow connected to the air stripper blower to control and treat potential fugitive emissions from this tank. If necessary in the future, this system can be adapted if the need arises for pretreatment of inorganics to reduce equipment fouling or to meet discharge permit requirements.

A schematic diagram of the ground water treatment system envisioned for the Interim RAP is presented in Figure 4. A site layout indicating the proposed treatment system location and transmission main routes is presented in Figure 5.

4.3. Permitting

4.3.1. Federal permits

Based on the constituents of concern, impacted media, and remedial actions considered for the site, no federal permits will be required except those which fall under the jurisdiction of the PADEP.

4.3.2. State/local agency permits

Based on the proposed remedial actions considered for the site and regulatory requirements, it is anticipated that several state/local agency permits will be required. The following list summarizes permits that may be required for the planned remedial actions:

- Valley Forge Water Authority Discharge Permit, Permit Modification or Discharge Authorization (an NPDES discharge permit being the alternative);
- Permit to Construct/Install/Alter Air Quality Control Apparatus/ Equipment;
- Certificate to Operate Air Quality Control Apparatus/Equipment;
- Chester County Well Drilling Permit; and,
- Delaware River Basin Commission - Ground Water Withdrawal Permit.

The most reliable method for the discharge of treated site ground water is to discharge to the POTW via the on-site sanitary sewer line. This method of discharge requires approval from both East Whiteland Township and the Valley Forge Sewer Authority (VFSA). Discharge of treated ground water to the POTW will require a VFSA Discharge Permit and will be subject to the VFSA pretreatment limits identified in Table 5.

Uncontrolled air VOC emissions from the proposed ground water treatment system at the design VOC concentrations would likely exceed one ton per year. Accordingly, discharge of air exhaust from the air stripper, and VOC emission control system will likely require a PADEP permit to construct and operate an Air Quality Control Apparatus.

4.4. Equipment/system installation

The ground water treatment system will be installed in the northeast corner of the existing site building (Figure 5). This location has been selected to eliminate the need for temperature protection and to facilitate the layout for electrical power connection and system piping. This building has a high ceiling and large bay door in the vicinity of the proposed treatment system location which will allow easy delivery/installation in this area. All of the treatment system equipment is anticipated to be located in this area of the building.

Piping from the planned extraction wells will be trenched up to the building perimeter; piping will then be located on the interior wall of the building leading to the treatment system. Electric equipment panels located in the interior of the building will be used as the source of power to the treatment system. Exhaust from the catalytic oxidizer will be discharged through a wall or roof vent. Treated effluent from the air stripper will be discharged via piping to the nearest sanitary sewer manhole (as currently planned).

4.5. Startup

Data will be collected during the initial one-week startup of the full-scale interim containment and ground water treatment system in a sampling program similar to the pilot test. Data collected during system startup will be analyzed to evaluate system performance and to identify operational changes which may be necessary. Anticipated data to be collected during startup are summarized in Table 6. O&M and system monitoring will be conducted as outlined in Section 5 of this Workplan.

5. IRAP operation and maintenance

5.1. Operation and maintenance plan

An Operation and Maintenance (O&M) Plan will be developed for the ground water containment and treatment system in accordance with the PADEP *Technical Guidance Manual* (Final Draft, December 1997). The O&M Plan will describe normal operation, monitoring, inspection, preventive maintenance and troubleshooting procedures for the ground water containment and treatment system. The O&M Plan will be developed based on the specific equipment and operational conditions of the final interim system. The O&M Plan will be submitted to the PADEP in a future Progress Report.

The following sections provide a general outline of O&M activities to be detailed in the O&M Plan.

5.2. System operation and maintenance

The full-scale ground water containment and treatment system will be monitored daily via remote telemetry to the system programmable logic controller (PLC). Through the use of PC-based software, the following system elements will be monitored/controlled at a minimum:

- submersible pump status, on/off control
- extraction well water level status
- pump/blower status, on/off control
- flow rate status
- pressure status (liquid and air streams)
- tank level status (equalization tank and air stripper sump)

The ground water containment and treatment systems will be monitored daily through the telemetry system to verify proper operation. An auto dialer system will be provided to signal an alarm to responsible personnel in the event of system malfunction (high water level, high pressure, etc.). Personnel will respond to address system malfunctions as needed. At a minimum, the site will be visited on a monthly basis to inspect the full scale system.

Maintenance activities anticipated for the ground water containment system include at a minimum:

- Piping from extraction wells to the treatment system will be cleaned on an as-needed basis by high pressure washing. Rinse water will be collected in the equalization tank.

- Flow meters, pressure gauges and level switches for each well will be inspected and cleaned quarterly.

- Safety equipment/systems will be inspected and maintained monthly.

- Pumps and blowers will be inspected and serviced monthly.

Safety equipment/systems for the ground water treatment system will be detailed in the HASP and are anticipated to include:

- eye wash station
- safety shower
- fire extinguisher
- first aid kit
- evacuation horn
- spill containment kits

5.3. Containment system performance monitoring

During operation of the interim hydraulic containment system, ground water quality and hydraulic monitoring data will be periodically collected. The purpose of this monitoring is to provide the technical data to assess the hydraulic and ground water quality effects of the containment system, and to modify the system or its operation, as necessary, to better achieve the IRAP objectives. The methods, frequency and evaluation activities to be conducted will be detailed in the O&M Plan. Generally, the containment system performance monitoring will include:

- hydraulic monitoring, including ground water levels (extraction/monitoring wells) and stream levels.

- instantaneous and cumulative flow monitoring.

- ground water and surface water sampling, including ground water sample collection from extraction wells/structures, monitoring wells and piezometers. Ground water and surface water samples are anticipated to be analyzed for VOCs, dissolved metals/fluoride and other field or indicator parameters.

The performance monitoring data to be collected during normal operation of the full-scale system is summarized in Table 7. These data will be compiled in the Site database and evaluated with respect to the objectives and criteria of the final interim containment system design.

5.4. Treatment system performance monitoring

The performance of the ground water treatment system will be monitored through sampling and analysis of influent and effluent water and air streams. Sampling of the treatment system will include collection of one influent ground water sample directly downstream of each recovery well, prior to the equalization tank, one water sample prior to the air stripper and one final effluent water sample prior to discharge to the sanitary sewer system. These influent and effluent samples will be sampled and analyzed for field parameters and VOCs by EPA Method 8260, as well as iron, manganese, alkalinity, hardness, TDS, TSS and any additional parameters required for discharge authorization. Additional effluent analysis will be completed in accordance with the effluent discharge authorization, as required. In addition, the air stripper off-gas stream will be monitored for VOCs pursuant to requirements under the air discharge permit. A summary of performance monitoring data to be collected during normal operation of the full scale system is presented in Table 7.

5.5. Progress reporting

Periodic IRAP Progress Reports will be prepared and will include the following:

- summary of O&M and monitoring activities conducted and monitoring/treatment data
- hydraulic evaluation of the containment system
- ground water and stream quality evaluation
- planned modifications to the containment or treatment system, if any, and changes to the O&M Plan
- schedule of IRAP activities.

Initially, it is anticipated that Progress Reports will be prepared on a quarterly basis after startup of the final interim system. The frequency of Progress Reporting is expected to be annually after the system stabilizes. The submittal of Progress Reports will also be reviewed in the context of the overall Site remedial approach (such as the entrance of the Site into the Act 2 program).

6. Sampling and Analysis Plan

This Sampling and Analysis Plan was prepared for the Ground Water Interim RAP to provide a detailed and documented guide for field, sampling and laboratory activities. The Sampling and Analysis Plan consists of the Field Sampling Plan and the Quality Assurance Project Plan (QAPP). The subsections 6.1 through 6.11 comprise the FSP; the QAPP is included in Appendix A.

6.1. Field Sampling Plan

The Field Sampling Plan (FSP) presents the field sampling, well construction, calibration, waste management and quality assurance/quality control (QA/QC) procedures for the Interim RAP elements. The FSP was prepared pursuant to and in accordance with PADEP and USEPA guidance documents and applicable American Society of Testing Materials (ASTM) standards.

6.1.1. Anticipated work elements summary

<u>Well Drilling - MW-21</u>

- one boring advanced to approximately 55 ft bg
- continuous split-spoon sampling of soils during drilling
- UV fluorescence and PID screening of split spoon samples
- soil selection for laboratory analysis of VOCs (based on screening)
- 10-inch casing set to 18 ft bg
- 6-inch casing set to 35 ft bg
- conversion of boring to a 6-inch, open-hole monitoring well/extraction well
- collection and inspection of rock drill cuttings
- grab ground water sample collection after casing installations and well development

Well Drilling - MW-22

- one boring advanced to approximately 95 ft bg
- continuous split-spoon sampling of soils during drilling
- UV and PID screening of split spoon samples and drill cuttings
- soil selection for potential laboratory analysis
- 10-inch casing set to 18 ft bg
- 6-inch casing set to 70 ft bg
- conversion of boring to a 6-inch, open hole monitoring well
- optional use of larger casings (14-inch and 10-inch casings) and third 6-inch diameter casing
- collection and inspection of rock drill cuttings
- grab ground water sample collection after casing installations and well development

Piezometer installations (PZ-1/PZ-2)

- borings advanced to the overburden bedrock interface (PZ-1), and into bedrock (PZ-2)
- continuous split spoon sampling of overburden soils
- UV fluorescence and PID screening of split spoon samples
- soil selection for potential laboratory analysis of VOCs
- for PZ-2, installation of 6-inch diameter casing, 3 ft into rock
- conversion of borings to 2-inch diameter PVC piezometers
- collection and inspection of drill cuttings
- piezometer development

Ground Water/Surface Water Sampling

- ground water sampling from existing monitoring wells as part of baseline ground water sampling event
- ground water sampling from newly installed monitoring wells/piezometers
- ground water sampling from one residential water supply well
- additional ground water sampling and pretreatment/post-treatment water sampling during the hydraulic containment/treatment pilot testing
- collection of surface water samples from Little Valley Creek

Hydraulic monitoring

- measurement of ground water levels periodically (initially monthly) in Site monitoring wells and piezometers
- measurement of surface water (stream) levels in Little Valley Creek
- additional hydraulic monitoring to be conducted during the hydraulic containment pilot testing

Investigation-derived waste (IDW) management
- containerization of IDW including: drill cuttings/fluids, development water, decontamination fluids, purged ground water, spent carbon during pilot testing and other IDW generated
- characterization of IDW as necessary for disposal and/or treatment

6.2. General sampling locations, numbers and matrices

6.2.1. Sample locations

Sampling locations are identified in the Workplan. A log book listing the various samples to be collected will be prepared for use on-site. The log book will also contain the type of sample and analytical matrix for each of the samples to be collected. Peel-off labels will be provided for marking the various containers to be used for sample collection. The sampler will be responsible for recording the exact sampling location and date/time in the field sampling notebook. The location will be described in the log book with a sketch that includes distances from field landmarks.

6.2.2. Sample numbering system

A sample numbering system will be used to identify each sample taken during the field investigation sampling program. This numbering system will provide a tracking procedure to allow retrieval of information regarding a particular sample and to assure that each sample is uniquely numbered. A listing of the sample identification numbers will be maintained by the sampler.

Sample numbering system will be used as follows:

Monitoring Well Ground Water Samples
- MW-prefix, or PZ-prefix
- ##-well number

Grab Ground Water Samples from Boreholes
- MW-prefix, or PZ-prefix
- ## - well number
- G-grab sample
- (##-##)-open hole or cased interval
- Example: MW-21-G-(35'-55')

Soil Samples
- Boring prefix (MW, PZ or other)
- ##-well/boring number
- SS - soil sample
- (#-#) - soil interval
- Example: MW-21-SS-(16'-16.5')

Surface Water Samples (Stream)
- Stream prefix
- # - sample location number
- # - approximate depth of surface water
- Example: Stream-1-6"

6.2.3. Sample matrices
The following matrices will be sampled and analyzed as part of the sampling program:

- soil
- surface water
- ground water

Additionally, air monitoring will be conducted in accordance with the HASP (Appendix B).

6.2.4. Field QA/QC samples
To evaluate the quality of data generated by the Workplan activities, field quality assurance (QA) and quality control (QC) samples will be collected. Field QA/QC samples are detailed in the QAPP (Appendix A).

6.3. Soil sampling procedures

6.3.1. Laboratory sample selection and headspace screening for VOC analysis
Soil samples from the soil zone will be scored with a decontaminated stainless steel trowel or similar implement and initially screened with a calibrated PID and visually/olfactorily inspected.. Visual inspection will include the use of UV light to activate fluorescence or potential residual

product, if present. A soil sample(s) will be collected from a 6-inch interval(s) from each split-spoon sample based on the results of the initial PID screening and visual, UV and olfactorily inspection. A portion of this 6-inch sample interval(s) will be placed in a headspace screening jar. The mouth of the screening jar will be covered with aluminum foil and sampled with the jar lid. After allowing the sample to reach ambient temperature out of direct sunlight, the jar lid will be removed and the probe of a calibrated PID will pierce the foil. The highest reading of the PID will be recorded on the soil boring log. The sample associated with the highest headspace reading will be submitted for laboratory analysis, in addition to other sample intervals at the sampler's discretion.

6.3.2. Soil sampling

Samples will be collected and documented, employing the procedures as outlined below:

1. Discard excessively disturbed or loose material found in the sampler which may not be representative of the interval sampled. This material will be discarded with boring spoils at each boring location.

2. *Screen samples in accordance with Section 6.3.1.*

3. Photograph (optional) portions selected for chemical analysis, showing an appropriate visual scale.

4. Remove the portion(s) of the sample selected for chemical analysis and place it into appropriate containers using a clean spatula. Soil intended for VOC analysis should be collected from the split barrel sampler during initial PID screening with a small diameter soil core sampling device. A 10 g (8-12g) soil sample will be collected and extruded directly into a tared sample container supplied by the laboratory performing the analyses, containing purge and trap grade methanol and surrogate compounds. Alternately, the soil sample for VOC analysis may be collected using a Encore® sampler and directly submitted to the laboratory (in accordance with EPA Method 5035B).

5. Visually examine the sample and record its characteristics on a soil boring log using the Unified Soil Classification System (*e.g.*, texture, color, consistency, moisture content, layering and other pertinent data).

6. Place the remainder of the sample in an archived "soil jar." This sample portion may be used for physical materials testing that may be required.

7. Decontaminate the sampling device in accordance with the procedure outline in subsection 6.8.

Immediately after the samples are collected, labeled vials and jars will be checked for completeness of the sampling objective and chain-of-custody procedures will be initiated.

The sampler must exercise considerable care while collecting samples for analysis. Methods to assure that high quality samples are collected are described below:

1. Make sure that the sample is obtained from undisturbed soil.

2. Carefully remove and discard portions of the sample that may have been cross-contaminated.

3. Conserve sample volume since under some soil conditions it may be difficult or impossible to achieve good sample recovery with split-barrel samplers.

Procedures employed to prevent potential cross-contamination during test boring sampling operations will include the following:

1. The sampling tools will be decontaminated prior to taking each sample;

2. The sampler will change gloves between each sample.

6.4. Monitoring well/piezometer construction

Monitoring well requirements will be in accordance with PADEP and/or ASTM specifications for monitoring wells for unconsolidated and consolidated formations (PADEP Ground Water Monitoring Guidance Manual, December 1997) and will include the following:

General

1. Chester County and East Whiteland Township well permits will be obtained for each monitoring well. The monitoring well permit tag and monitoring well designation number will be permanently affixed to each monitoring well.

2. Copies of the site specific monitoring well specifications will be maintained at the drilling site by the supervising geologist.

3. The monitoring well will be installed by a Pennsylvania licensed well driller using the specified drilling method to a depth specified by the supervising geologist.

4. The borehole diameter will be a minimum of 4 inches greater than the well screen diameter, if applicable.

5. Grouting materials will include one of the following:

   Neat Cement - 6 gallons of water per 94 pound bag of cement.

   Granular Bentonite Slurry - 1 gallon of water per 1.5 pounds of bentonite.

6. All grout and bentonite slurry will be placed using a tremie pipe. Grout levels will be verified by frequent measurement using drop tape or other method. Potable water will be used for mixing grouting materials and drilling fluids.

7. Only threaded joints will be used as couplings for PVC well materials. Steel casing joints will be welded or threaded joints. Solvent welds will not be permitted.

8. After installation of each outer/inner steel casing, the well will remain undisturbed for a minimum of 12 hours. A grab water/fluid sample will be collected from the bottom of the borehole. Water/drilling fluids will be pumped and/or blown from the casing and the casing then checked for infiltrating water. If water enters the casing, the rate of infiltration will be measured and a water sample will be collected for analysis. If infiltrating water is identified, drilling will not continue until the water analysis results are known and evaluated.

9. The driller will maintain an accurate written log of all materials encountered, record construction details for each monitoring well, and record the depths of water bearing zones. A Water Well Completion Report will be prepared and submitted by the driller to the Bureau of Topographic and Geologic Survey (per Act 610).

10. The top of each monitoring well casing will be surveyed to the nearest 0.01 ft, mean sea level, by a Pennsylvania licensed surveyor. The survey point will be marked on each monitoring well. The horizontal location of each monitoring well will also be surveyed to State Plane Coordinates.

11. Drill cuttings will be placed in approved 55-gallon drums or rolloff containers and stored in a secure location pending analysis and disposal.

12. Following installation, each monitoring well will be developed for a minimum of 1 hour using pump and surge methodology. The well screen or open-hole section will alternately be pumped and surged to provide a relatively sediment free ground water sample. Water generated during the development process will be contained in approved 55-gallon drums or holding tank and stored in a secure location pending analysis and disposal.

Overburden/Piezometer Well Construction

The overburden wells and piezometers will be installed using hollow stem augers (HSA) or other drilling methods at the discretion of the Project Manager and oversight geologist. Overburden wells or piezometers will be constructed with 5 or 10-ft lengths of Schedule 40 polyvinyl chloride (PVC) screen with 0.010-inch slots attached to an appropriate length of Schedule 40 PVC riser casing (as specified in the workplan). Overburden wells will be constructed of 4-inch diameter materials whereas piezometers will be constructed of 2-inch diameter materials. Piezometers installed into the underlying bedrock will be double cased with a steel casing grouted approximately 3 ft into the bedrock. The wellheads will be secured against tampering through the use of either water-tight flush mounted locking road boxes or lockable, stick-up steel protective casings.

The overburden wells/piezometers will be installed by initially advancing a borehole from the ground surface to the intended depth of the well. Soil samples will be collected continuously using a 2 ft long split barrel sampler in accordance with ASTM Method D-1586-84. The soil samples will be screened and described in accordance with the procedures outlined in subsection 6.3.

After advancing the borehole, the wells/piezometers within unconsolidated material will be installed by placing the screen and casing assembly through the auger string once the screen interval has been selected. It is generally the intention to complete the well so that the water table (if defined) will remain within the screened interval, unless the specific purpose of the overburden well/piezometer dictates a screen interval below the water table. Washed, graded silica sand pack will be placed approximately 2 ft above the top of the screen to prevent screen plugging. A minimum of 2 ft of bentonite will then be added to ensure proper sealing. (The sand pack and bentonite seal thicknesses may be modified if necessary based on well depth.) A cement/bentonite slurry will then be tremie grouted to ground surface. During placement of sand and bentonite slurry, frequent measurements will be made to check the height of the sand pack and thickness of the bentonite layer by a weighted drop tape measure.

For piezometers installed within the bedrock, the following procedures will be used. A nominal 10-inch diameter borehole will be advanced from the ground surface to approximately 3 ft into the bedrock using HSA drilling methods (or other appropriate drilling methods). Soil samples will be collected continuously using a 2 ft long split barrel sampler in accordance with ASTM Method D-1586-84. The soil samples will be screened and described in accordance with the procedures outlined in subsection 6.3. A 6-inch diameter steel casing extending from the bottom of the borehole to the ground surface will be installed in the borehole and grouted in-place. After allowing the grout to cure for a minimum of 12 hours, a nominal 6-inch diameter borehole will be advanced using an appropriate drilling method to the desired depth of the piezometer. The 2-inch diameter PVC materials will be installed in the borehole and the annular space will be filled with a wash graded sand filter pack and grouting materials as discussed above.

For wells/piezometers completed above grade, vented, protective steel casing will be placed over the riser pipe approximately 3 ft below grade and 2 ft above grade. The protective casing will be secured by a Portland cement seal/collar. The cement seal will extend laterally a minimum 1 ft. in all directions from the protective casing and will slope gently away to drain water away from the well. A vented steel cap will be fitted on the protective casing and a steel hasp shall be welded to one side of each steel clasp so the cap may be secured with a steel lock.

Single-cased bedrock monitoring well installation
Single-cased monitoring wells will be installed using HSA, pneumatic air hammering, ODEX or other drilling methods at the discretion of the Project Manager and oversight geologist.

The HSA drilling method (or other appropriate drilling methods) will be used to advance a nominal 10-inch diameter borehole to bedrock. The overburden soil samples will be collected continuously suing 2-inch split barrel samplers from the ground surface to the top of bedrock at 2 ft intervals using ASTM Method D-1586-84. A 6-inch diameter steel casing will be set approximately 3 ft into bedrock and grouted in place. A minimum of 12 hours will be required to allow the grout to set. A nominal 6-inch diameter borehole will be advanced into the bedrock using an appropriate drilling method. The well will be completed as an open hole or PVC well design as specified in the Workplan.

Double-cased bedrock monitoring wells installation
Double-cased bedrock monitoring wells will be installed using mud-rotary, pneumatic air hammering, ODEX or other similar drilling method at the discretion of the Project Manager and oversight geologist..

The appropriate drilling method, using a minimum of a 14 in. diameter drill bit, will be used to advance the borehole from grade to the bottom of the first casing interval. A 10 in. diameter standard steel casing will be grouted in place to approximately 3 ft into bedrock. A minimum of 12 hrs will be required to allow the grout to set. After the casing is set, mud rotary or other drilling method will be used to advance nominal 10-inch diameter borehole through the casing until the end of the inner case depth is reached. Field and instrumental screening data will be entered on the coring log. A 6-inch diameter steel casing will be grouted in place. A minimum of 12 hrs will be required to allow the grout to set. The bedrock borehole will then be advanced using a 5 7/8-inch diameter pneumatic air hammer bit or other method to the well completion depth. The well will be completed using an open hole design or PVC monitoring well per specifications in the Workplan.

6.5. Ground water sampling plan

6.5.1. Purpose

The purpose of the ground water sampling plan is to provide the field sampling personnel with detailed methods and procedures for conducting the ground water sampling activities at the Site in a manner consistent with the QAPP (Section 6.2) to achieve the data quality objectives. The field sampling and data collection methods are consistent with the *Groundwater Monitoring Guidance Manual* (PADEP, February 1996).

6.5.2. Ground water level measurements

Prior to conducting ground water purging and sampling activities at the Site, the depth to ground water will be measured relative to the well casing in the monitoring wells or piezometers. Depth to ground water will be measured from the permanently marked reference point on the casing to the nearest 0.01 ft using an electronic water level meter and will be subtracted from the surveyed well casing elevation to obtain the ground water potentiometric elevation in ft relative to mean sea level. The water level meter will be decontaminated between each well location per subsection 6.8.

6.5.3. Monitoring well/piezometer ground water sampling procedures

The following procedures will be used to obtain representative ground water samples. A pre-cleaned, submersible pump will be used to purge and sample the overburden and bedrock monitoring wells. Additional equipment that is required includes an electronic water level probe, water parameter meters (pH, specific conductivity, temperature, turbidity, Eh, and dissolved oxygen), sample containers, a photoionization detector (PID), decontamination materials, and sample coolers. Other miscellaneous equipment will be needed to complete the sampling, such as hand tools and keys.

Prior to sampling activities, the following will be reviewed with project personnel:

- Ground Water Sampling Plan
- Quality Assurance Project Plan
- Health and Safety Plan
- Sample bottle preservation, packing, and shipping requirements
- Analytical methods
- Well construction information

The laboratory will be contacted to provide clean sampling containers with the appropriate preservative, trip blanks, water for field rinsate blanks, sample labels, and coolers.

The following procedures will be followed for each well sampled. Ground water sampling activities will proceed from monitoring wells with ground water that has historically indicated the lower concentration of VOCs to monitoring wells with ground water that historically have indicated the higher concentrations of VOCs.

Presampling activities

1. Assemble the sampling equipment and check that it is operational. Decontaminate the sampling equipment following the decontamination procedures outlined below. These procedures are in accordance with the PADEP *Groundwater Monitoring Guidance Manual* (February 1996).

    - For the submersible pump, wash the outside of the pump using a nonphosphate detergent and potable water. The pump will be washed with a stiff bristled brush. Also, the detergent solution and clean, potable water will be circulated through the pump. Rinse the outside of the pump thoroughly with tap water and circulate the tap water through the pump. The pump will then be rinsed with a 10% nitric acid solution (if metals analyses are being conducted) followed by a rinse with deionized water.

    - The electronic water level meter will be initially scrubbed/washed with a detergent/potable water solution followed by a potable water rinse and a final deionized water rinse. Between wells, the probe will be rinsed with deionized water at a minimum.

    - The water quality meters will be rinsed with deionized water between well locations. Containers used in conjunction with the water quality meters will also be rinsed with deionized water between well locations.

- Calibrate water parameter meters and air monitoring device in accordance with the manufacturers operational manual and document this calibration in a bound field notebook or field calibration log. Calibration of these meters will be conducted once per day at a minimum.

2. Check the number and type of sampling containers. Check for the presence of preservative, such as acids or bases, if required.

3. Prepare field documents including bound field notebook, ground water sampling forms, equipment calibration forms and chain-of-custody forms. These forms are included in the following pages. Record the well number, date, time, casing diameter, screened interval, sampling equipment, sampler names, and other pertinent information, such as weather conditions, on the ground water sampling form. Forms are to be completed in their entirety in the field, unless weather conditions make this impractical.

O'BRIEN & GERE ENGINEERS, INC. Ground Water Sampling Log

Date
Site Name ______
Site Location ______
Personnel ______

Weather ______
Well # ______
Project # ______
Evacuation Method ______

Depth of Well * ______ ft.
Depth to Water * ______ ft.
Length of Water Column ______ ft.
Water Volume in Sand Pack ______ gal.(s)
Water Volume in Well Casing ______ gal.(s)
One Purge Volume ______ gal.(s)
Three Purge Volumes ______ gal.(s)

Casing Volume /ft. for:
2" Diameter Well = 0.163 X LWC
4" Diameter Well = 0.653 X LWC
6" Diameter Well = 1.469 X LWC

Volume removed before sampling ______ gal.(s)
Did well go dry? ______

* Measurements taken from
☐ Top of Well Casing
☐ Top of Protective Casing
(Other, Specify)
☐ ______

Purge Rate (gpm) ______

Water parameters:

Time	Volume Removed (Gallons)	Temp.	pH	Sp. Cond.	Eh	Turbidity	Dissolved Oxygen

Water Sample:
Time Collected ______

Physical Appearance at Start

Color ______
Odor ______
Turbidity (> 100 NTUs) ______
Sheen/Free Product ______

Physical Appearance at Sampling

Color ______
Odor ______
Turbidity (> 100 NTU's) ______
Sheen/Free Product ______

Parameters of Samples:

Container Size	Container Type	# Collected	Filtered	Preservative

NOTES:

CALIBRATION DATA SHEET

Equipment Name			
Model Number			
Serial Number			
□ New	Serviced	□ As Found □ As Left	□ In Tolerance □ Out of Tolerance

Standards Used: ____

____

____

____

____

____

Comments: ____

____

____

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____

____

____

____

AT STANDARD CONDITIONS:
TEMPERATURE =
ATMOSHPHERIC PRESSURE =

i\...training\calibsht.wpd

777 New Durham Road
Edison, New Jersey 08817
Phone: (732) 549-3900 Fax: (732) 549-3679

CHAIN OF CUSTODY / ANALYSIS REQUEST

Name (for report and invoice)	Samplers Name (Printed)	Site/Project Identification
Company	P.O. #	State (Location of site): NJ: ☐ NY: ☐ Other:
		Regulatory Program:
Address	Analysis Turnaround Time Standard ☐ Rush Charges Authorized For: 2 Week ☐ 1 Week ☐ Other ☐ ________	ANALYSIS REQUESTED (ENTER "X" BELOW TO INDICATE REQUEST)
City State		LAB USE ONLY Project No: Job No:
Phone Fax		

Sample Identification	Date	Time	Matrix	No. of. Cont.												Sample Numbers
Preservation Used: 1 = ICE, 2 = HCl, 3 = H_2SO_4, 4 = HNO_3, 5 = NaOH				Soil:												
6 = Other ________, 7 = Other ________				Water:												

Special Instructions ________________ Water Metals Filtered (Yes/No)? ____

Relinquished by	Company	Date / Time	Received by	Company
1)		|	1)	
Relinquished by 2)	Company	Date / Time |	Received by 2)	Company
Relinquished by 3)	Company	Date / Time |	Received by 3)	Company
Relinquished by 4)	Company	Date / Time |	Received by 4)	Company

Laboratory Certifications: New Jersey (12543), New York (11452), Pennsylvania (68-522), Connecticut (PH-0200), Rhode Island (132). Massachusetts (M-NJ312), North Carolina (No. 578)

Sampling activities

1. Prepare the well head for sampling. Clean an area around the well head such that the integrity of the sampling equipment will not be compromised. If the area cannot be cleaned, place a drop cloth over the area to prevent contaminating the sampling equipment. Cut a slit in the center of a plastic sheet and slip it over the well creating a clean surface onto which the pre-cleaned sampling equipment can be placed. In the event that it is not practical to place the plastic sheeting over the well such as inclement weather, the sampling equipment will be placed on plastic sheeting next to the monitoring well.

2. Put on a new pair of disposable gloves (at a minimum, consult the HASP).

3. Prepare well heads for ground water sampling by removing the inner well plugs. For monitoring wells that do not have ventilated well plugs, allow approximately 10 minutes for the ground water elevation to stabilize. If the monitoring wells cannot be vented due to accumulation of water inside the protective casing, evacuate the water (e.g. bailing) from around the well casing before removing the inner well plug. The presence of standing water inside the protective casing should be noted in the bound field notebook.

4. After opening the inner well plug, screen the headspace with a PID to detect the presence or absence of volatile organic compounds. Record the results of the headspace screening in the bound field notebook. Monitor the breathing zone periodically during ground water sampling in accordance with the HASP.

5. Measure the depth to ground water in the monitoring wells using an electronic water level probe graduated to 0.01 ft. Measure the depth to the water table from a designated mark on the riser well casing. If a designated mark is not found on the casing, measure the depth to water from the point on the well casing opposite the lock clasp (above ground casing) or bolt thread, and permanently mark the measuring point. Repeat ground water elevation reading three times for verification. Record the depth to ground water measurement.

6. Measure the well depth using the electronic water level probe and record the measurement in the bound field notebook. The well depth measurement will be used to assess the integrity of the well and will be used, along with the depth to water measurement, to calculate the volume of water in the well.

7. Calculate the volume of water in the well casing using the following equation:

   $V = (\pi)(r^2)(h)$ where:
   V = well volume (ft^3)
   r = casing radius (ft)
   h = height of water in the well (total well depth minus depth to water) (ft)
   $\pi = pi \cong 3.14$

   The volume of water in the sand pack will estimated using a 30 percent porosity for the sand and will be calculated based on the borehole diameter provided on the well construction logs. The volume of water in the sand pack will be added to the volume of water in the well casing to estimate the well volume.

8. Attach a length of dedicated Teflon®-lined tubing to the precleaned submersible pump and lower the submersible pump to the approximately 2 ft below the top of the water column.

9. Begin purging the stagnant water from the well at a low flow rate (0.1 to 0.5 gpm) and gradually lower the pump to the middle of the well screen or the middle of the open-hole internal for bedrock wells. If possible depending on well yield, the water level will be maintained during purging above the top of the well screen or above the inner casing for open-hole bedrock wells. The flow rate may be increased based on the well yield provided the water level stabilizes, the water level declines not more than 10% of the water column, and the water level conditions above are met. The water level will be monitored and recorded every 5 to 10 minutes.

10. If the well can not sustain flow even at the lowest possible flow rate of the pump, then the pump will be lowered to within 2 ft of the well bottom. If the well is purged dry (*i.e.* to the pump intake), then sampling shall commence as soon as the well has recharged to a sufficient level to collect the appropriate volume of samples with the pump.

11. Purge water will be contained in a portable storage tank. Field measurements of temperature, specific conductivity, pH, turbidity, dissolved oxygen, and Eh of the purge water will be taken every 15 minutes (or as frequent as possible), including a reading after each well volume of water is purged. Purging activities will continue until field measurements have stabilized based on three consecutive readings (pH ± 0.2, specific conductivity ± 10%, temperature ± 1°, dissolved oxygen ± 10%, turbidity ± 10%, and Eh ± 10%). The purge method, pump rate, pump type, field parameter measurements, and volume of water purged will be recorded along with the start and end time of purging.

12. Samples will be collected as soon as possible after the field parameters and water levels have stabilized as above. The sampling bottles should be removed from their transport containers and prepared for receiving water samples. Inspect the labels to ensure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive the water samples. Arrange the sampling containers to allow for convenient filling.

13. Ground water samples will be collected through the pump and Teflon® lined discharge tubing. Prior to sampling, the discharge flow rate will be decreased to approximately 0.1 liters per minute (0.03 gpm), or as low as possible for 6-inch diameter and larger diameter wells depending on the submersible pump.

14. Begin by filling the containers labeled for volatile organic analysis (40 ml VOA vials) first. Carefully fill and cap the 40 ml vials. As these sampling containers are preserved with hydrochloric acid, do not overfill during sampling. Turn the vial upside down, gently tap the vial cap, and check for air bubbles. If properly filled, the vials should not have visible air bubbles. If air bubbles are present, then discard the vial and fill another. Sample containers for nonvolatile analysis will be filled to approximately 90 percent capacity, unless, otherwise specified by the laboratory.

15. Samples for dissolved metals from each well will be field filtered using dedicated 0.45 micrometer filters. The samples will be filtered using either an in-line filter, or the water will be contained in a non-preserved bottle and filtered using a portable field filtering apparatus. Prefiltering may also be performed (e.g. 10 micron filter), provided the decontamination and preservation requirements are met.

16. Record the sample time and physical appearance of the ground water observed during sampling.

17. QA/QC samples, including field duplicates, trip blanks, matrix spike, matrix spike duplicates, and field rinsate blanks, will be collected at a frequency outlined in the QAPP.

18. Label each sample container with the site name, well identification, date, time of day, preservative (if any), and analysis to be performed.

19. Transfer the filled sample containers immediately to an ice-filled transport container such as a cooler and chill to 4° C. The ice should be placed within a sealable bag to minimize generation of water during transport. Care should be taken to not allow the sample containers to freeze.

20. Complete the Chain-of-Custody Record (sample attached). Analytical methods are described in the QAPP.

<u>Post-sampling activities</u>

1. After ground water sampling is completed, extract the pump and piping from the well (wearing Tyvek overalls at a minimum; consult HASP) and replace the well cap and lock the well protection assembly before leaving the well location. Wells will not be left open and unattended during the field activities.

2. Prepare the purging and sampling equipment for decontamination in accordance with the decontamination protocol. Remove and dispose of gloves and other personnel protective equipment used during purging and sampling activities (see HASP).

3. The number of containers and types of analysis for the samples will be recorded on the Ground Water Sampling Log. Samples will be shipped following chain-of-custody procedures to the laboratory within 24 hrs of sample collection in accordance with the QAPP. Include adequate packing and ice with the samples.

4. Place the non-reusable materials into a plastic bag, drum or other designated containers on-site and stage for appropriate disposal.

6.6. Residential well water sampling

- Untreated ground water samples from the residential well will be sampled from the existing spigot closest to the well, prior to any type of current treatment system or holding tank, as practical. The spigot will be opened and water will be discharged to a nearby sink or drain for approximately 20 minutes prior to sampling to obtain a representative water sample. If the water sampling point is after the holding tank, the holding tank volume will be flushed by pumping to the extent practical prior to sampling. After a minimum of 20 minutes, the water sample will be collected directly to clean, laboratory-supplied containers (with preservative if applicable) from the spigot and placed in an ice-filled cooler.

- The collected samples will be submitted for laboratory analysis using EPA methods per the workplan and QAPP by a laboratory certified by the Commonwealth of Pennsylvania for drinking water analyses. For QA/QC purposes, a trip blank will accompany each cooler shipment to the laboratory if analysis is conducted for volatile organics.

- The sample containers will be labeled by the sampler to reduce the possibility of misidentification. The sample label will contain the field sample number, sample description, date and time sampled, initials of samplers, preservation, and the required analysis. The sample identification will be recorded on the chain-of-custody form. The original chain-of-custody will accompany the sample containers during transport to document custody of the samples. Custody procedures will be in accordance with the QAPP.

6.7. Surface water sampling

Surface water samples will be collected periodically from the Little Valley Creek as specified in the Workplan according to the following procedure:

- At the surveyed stream sampling point (sounding rod), the stream water level will be measured and recorded.

- A bottle sampler or dipper will be lowered into the liquid and lifted out while avoiding splashing or otherwise disturbing the surface layer. The sample is then poured into the laboratory-supplied sample containers.

- When volatile organic analysis (VOA) will be performed, sampled obtained with a dipper shall be poured into an appropriate container (VOA vial) with minimal contact and agitation.

- Dippers, if used, will be obtained commercially. Disposable dippers are convenient for use with hazardous materials, and the dipper selected must be constructed of materials compatible with the liquid being sampled and with the tests or analysis being performed. Light weight and rigidity are important characteristics of the extension handle.

- Plastic, glass, or other nonreactive containers will be used (refer to the QAPP).

- Have sample containers ready for use. Assemble the dipper, if used, and, if desired, the extension handle for the sample.

- Lower the dipper or bottle sampler slowly into the liquid. The sampler should be on its side so that liquid runs into the container without bubbling or swirling. Rotate the sampler so the lip of the container is up, preventing the sample from running out. Lift the sampler from the liquid.

- If using a dipper, pour the sample from the sampler down the side of the sample container. Avoid splashing of the sample.

- Leave adequate air space in the container to allow for expansion, except for VOA vials. Fill VOA vials to the lip, and seal with no headspace to prevent loss of volatiles.

- Complete the field log book and chain-of-custody forms.

- Decontaminate the used equipment as specified in this workplan.

6.8. Decontamination of sampling equipment

Decontamination of nondisposable sampling equipment will be conducted in accordance with the PADEP *Ground Water Monitoring Guidance Document*, applicable ASTM standards and in general EPA guidance, decontamination procedures for aqueous sampling equipment will be as follows:

1. Non-phosphate detergent and potable water wash;
2. Potable water rinse;
3. Deionized water rinse;

*4. 10% nitric acid rinse;
*5. Deionized water rinse;
**6. Acetone (pesticide grade) or methanol rinse (except pumps);
**7. Total air dry or nitrogen blow out; and
**8. Deionized water rinse.

* Only if sample is to be analyzed for metals
** Only if sample is to be analyzed for organics

For non-aqueous sampling equipment, the following decontamination procedures will be used:

1. Non-phosphate detergent and potable water rinse.
2. Generous potable water rinse.
3. Deionized water rinse.

Information concerning decontamination methodology, date, time, and personnel will be recorded in the field log book. Deionized water from commercial vendors will be used for decontamination of sampling equipment only if it has been verified by laboratory documentation that it has been deionized. Field decontamination will be performed over a suitable container or catchment system such that decontamination wastes can be collected and placed in approved 55-gallon drums or other containers. The nature of the container or catchment system will depend upon the equipment being decontaminated. Field decontamination residuals will be staged in a secure location pending analysis and disposal

Preparation of samples for shipment is performed in the following manner:

1. Label bottles with sample number and sample type. Each sample set will have a unique sample number. Labels will be secured with tape.

2. Check Department of Transportation regulations to insure that samples are packaged correctly for transportation. Should any problems or questions arise with preparation of samples for shipment, contact the Project Manager.

3. Package samples in the approved shipping container. Laboratory paperwork is to be included with the samples. Check that samples are cooled to recommended temperature prior to sealing shipping container.

4. Ship samples immediately to the laboratory. The laboratory's name and address should be clearly marked on the shipping container.

6.9. IDW management

Investigation-derived wastes (IDW) including drill cuttings, decontamination residuals, well development water, and well purge water will be collected and stored in DOT-approved 55-gallon drums, holding tanks or other appropriate containers in a designated storage area. This material will be characterized and subsequently disposed or recycled at permitted facilities. The number, type and laboratory analyses for waste characterization samples will depend upon the waste destination facility. Sampling procedures and laboratory methods will be in accordance with PADEP, EPA and/or ASTM protocols and will in general, conform to this Sampling & Analysis Plan as applicable.

6.10. Field equipment calibration

Field equipment used during this investigation will be calibrated in a manner and at a frequency in accordance with the manufacturer's instructions. The equipment will also be operated in accordance with the manufacturer's instructions. Field equipment used during this project that is not covered by the standard operating procedures referenced herein will have a specific calibration and operation instruction sheet prepared for it by the personnel who will be using the equipment in the field. Calibration procedures undertaken involving field equipment will be recorded in a field notebook.

The calibration range will be designed to bracket the concentrations of concern.

6.10.1. Field standard operating procedures (SOPs) - pH meter
Purpose - The purpose of this SOP is to provide supplemental instruction for operating the pH indicator.

Applicability - This SOP applies to personnel when using a pH indicator.

Responsibilities
Operator's Responsibilities - The operator of the pH indicator is responsible for operating and calibrating the instrument in accordance with the following instructions.

Field Operations Manager's Responsibilities - The field operations manager is responsible for verifying the operator's compliance with this SOP.

Recordkeeping - Recordkeeping for the pH indicator will be in accordance with the site specific work plan. Calibration and maintenance records will be kept in a logbook.

Procedures

Operating Procedure - Remove the protective cap. Turn on the pH meter and dip into the test solution up to immersion level. Under no circumstances immerse above display level. Stir gently and wait a few seconds (if the temperature of the test solution differs from the ambient temperature, wait for a longer duration of 1 to 2 minutes before taking readings. This is to ensure that thermal equilibrium between electrode and solution has been attained). If electrode is dry, wait a while longer. White crystals may form on the cap. This is a normal process.

Calibration - At a minimum, the pH meter will be calibrated at the beginning of each sampling day. Prior to calibration, the pH meter will be conditioned as follows. Remove the cap and soak the sensor for at least one half hour in either 4.0 or 7.0 pH buffer, or tap water. Immerse the sensor end up to the maximum immersion level. To calibrate, dip the pH meter in pH 7.0 calibration buffer solution and adjust the offset adjustment trimmer so the display reads 7.0. Then rinse the pH meter electrode in clean water. Dip the pH meter in a second buffer solution, usually pH 4.0 or 10.00. Adjust the slope adjustment trimmer so the display reads the buffer value rounded to the nearest tenth of a pH. Rinse the pH meter as described above and check the calibration in the buffers, rinsing between buffers. Rinse again. Now the pH meter is ready for use.

Maintenance - Take quick readings of aggressive solutions, heavy metals or proteins. Rinse immediately with water to remove any residue from the electrode. When storing the pH meter, insert a small piece of white issue or sponge in the base of the cap, wet with the same liquid you used to condition (see above), and then replace the cap firmly. This retards leakage from the reference electrode and prolongs the useful life of the pH meter.

6.10.2. Field SOP - specific conductance meter

Purpose - The purpose of this SOP is to provide supplemental instruction for operating the Conductivity Meter.

Applicability - This SOP applies to personnel when using a Conductivity Meter.

Responsibilities

Operator's Responsibilities - The operator of the conductivity meter is responsible for operating and calibrating the instrument in accordance with the following instructions.

Field Operations Manager's Responsibilities - The field operations manager is responsible for verifying the operator's compliance with this SOP.

Recordkeeping - Recordkeeping for the conductivity meter will be in accordance with the site specific work plan. Calibration and maintenance records will be kept in a logbook. .

Procedures

Operating Procedure - Remove the protective cap from the bottom of the meter. Turn on the meter. Immerse meter to the level indicated, approximately 1-1/2 inches into the test solution. Do not immerse above display level. Stir gently and wait a few seconds for reading to stabilize.

Calibration - At a minimum, the conductivity meter will be calibrated at the beginning of each sampling day. To calibrate the conductivity meter, immerse the probe in a standard solution and adjust the reading using the trimmer located next to the pocket clip on the back of the unit.

6.10.3. Field SOP - temperature

Purpose - The purpose of this SOP is to provide supplemental instruction for operating the temperature indicator.

Applicability - This SOP applies to personnel when using a temperature indicator.

Responsibilities

Operator's Responsibilities - The operator of the temperature indicator is responsible for operating and calibrating the instrument in accordance with the following instructions.

Field Operations Manager's Responsibilities - The field operations manager is responsible for verifying the operator's compliance with this SOP.

Recordkeeping - Recordkeeping for the temperature indicator will be in accordance with the site specific work plan. Calibration and maintenance records will be kept in a logbook.

Procedures

Operating Procedure - Remove the protective cap. Connect with one of the four probes (L,M,C, or P). Turn on. Under no circumstances immerse above connector. Do not disconnect the probe unless necessary. Change batteries as necessary.

Calibration - At a minimum, the temperature indicator will be calibrated at the beginning and end of the sampling program to check instrument drift. The temperature indicator will be calibrated according to the manufacturer's instructions.

6.10.4. Field SOP - HNu® photoionization detector (or equivalent)
Purpose - The purpose of this SOP is to provide supplemental instruction for operating the HNu® photoionization detector (PID) or equivalent. It is to be used together with the "HNu® Model PI 101 Tracer Gas Analyzer Instruction Manual," and the RAWP. The 10.2 eV lamp will by used at the Site.

Applicability - This SOP applies to personnel when operating an HNu® PID.

Responsibilities

Operator's Responsibilities - The operator of the HNu® photoionization detector is responsible for operating and calibrating the instrument in accordance with the "HNu® Model PI 101 Trace Gas Analyzer Instruction Manual," and the work plan.

Field Operations Manager's Responsibilities - The field operations manager is responsible for verifying the operator's compliance with this SOP.

Recordkeeping - Recordkeeping for the HNu® photoionization detector will be in accordance with the site specific work plan. Calibration and maintenance records will be kept in the Calibration and Maintenance notebook.

Procedures

Operating Procedure - The HNu® will be operated in accordance with the operating procedures listed in the Operation section of the "HNu® Model PI 101 Tracer Gas Analyzer Instruction Manual."

Calibration - At a minimum, the HNu® will be calibrated at the beginning of each sampling program day. The HNu® will be factory calibrated when malfunctioning. The HNu® will be calibrated in accordance with the calibration procedures listed in the Calibration section of the "HNu® Model PI 101 Tracer Gas Analyzer Instruction Manual."

Maintenance - The readout unit is to be wiped with a tissue soaked with soap and water and the battery is to be charged after each use. The UV light source window is to be cleaned at least once a month or as use and site conditions dictate. The ionization chamber is to be cleaned at least once a month. The HNu® will be maintained in accordance with the maintenance procedures listed in the Maintenance section of the "HNu® Model PI 101 Tracer Gas Analyzer Instruction Manual." Troubleshooting procedures for the HNu® are listed in the Troubleshooting section of the "HNu® Model PI 101 Tracer Gas Analyzer Instruction Manual."

If desired, a Photovac® MicroTip PID may be used instead of the HNu® instrument. Calibration of the MicroTip will be performed at the beginning of each sampling day according to the manufacturer's instructions.

6.10.5. Field SOP - ultraviolet (UV) light

Purpose - The purpose of this SOP is to provide supplemental instruction for operating the UV light for field screening of fluorescence. It is to be used together with the "Operating Instructions, Mineralight®, UVL-56 Black-Ray® Ultraviolet Lamps" (UVP, Inc.) and the RI Workplan.

Applicability - This SOP applies to personnel when operating the UV light.

Responsibilities

Operator's Responsibilities - The operator of the UV light is responsible for operating and maintaining the instrument in accordance with the Operating Instructions and the work plan.

Field Operations Manager's Responsibilities - The field operations manager is responsible for verifying the operator's compliance with this SOP.

Recordkeeping - Recordkeeping for the UV operation will be in accordance with the site specific work plan. Maintenance records (as needed) will be kept in the Calibration and Maintenance notebook.

Procedures

Operating Procedure - The UV light will be operated in accordance with the operating procedures listed in the operation section of the "Operating Instructions".

Maintenance - Upon depressing the light on button, observe the lamp to check if the light has turned on. If the lamp intensity or the lamp decreases considerably, a new filter may be needed. The UV light source window, eye piece and cabinet are to be cleaned at least once a month or as used and site conditions dictate. The UV light will be maintained and troubleshooted in accordance with the maintenance procedures listed in the "Operating Instructions".

6.11. Reporting and documentation

Field documentation is an essential part of the ground water IRAP. The field crew will be supervised by a field manager, who is responsible for written documentation. Field log books and field forms will serve as permanent field documentation for the monitoring activities.

6.11.1. Field log book

A bound field log book will be maintained by a field manager, or designee, for documentation purposes. The log book will contain information such as names of workers, weather conditions, samples collected, measurements, and significant events, observations, or other pertinent data - notably, unusual occurrences during investigations. Pages will be numbered, signed and dated. Field notebooks will be kept neat and organized. Original data recorded in filed notebooks will be written in waterproof ink. Entries will be legible, factual, detailed, and objective.

If an error is made on an entry, corrections will be made crossing a single line through the error and entering the correction information above. Erroneous information will not be erased, obliterated, or torn out. Errors in the field log will be corrected by the person who made the entry. Corrections will be initialed and dated.

The following items will typically be included in the field notebook:

- Name, address, and phone number of the field team leader.
- Owner and client information.
- Names and affiliations of the personnel on-site.
- General description of the day's field activities.
- Documentation of weather conditions during sampling.
- Location of sampling

7. Interim RAP implementation and schedule

7.1. Implementation

This section briefly describes the implementation of the Interim RAP elements and relationship of the various project plans.

7.1.1. Completion of interim final design

As noted in Section 2, the following interim design tasks have been completed:

- IRAW development
- Pilot test design (with system modifications to be made as required for water discharge approval)
- Hydraulic monitoring (on-going on monthly schedule)
- Baseline ground water sampling event (report pending)
- Residential well water sampling
- RWTS design, installation and sampling (O&M initiated)

7.1.2. Permitting

Pilot test permitting activities will be completed to facilitate the discharge of treated ground water. Discussions have been initiated with the Valley Forge Sewer Authority and East Whiteland Township for use of the local sanitary sewer system. Approval/permitting of this discharge is critical prior to initiation of the planned pilot test, and the full-scale (permanent) remediation system.

Well installation permit applications for the new monitoring wells and piezometers will be submitted to Chester County and East Whiteland Township. Upon receipt of permits, well installation activities will be initiated.

7.1.3. RWTS installation, O&M and monitoring

The RWTS was installed on March 31, 1999 after access was required from the residence for the installation. O&M of the RWTS has been initiated, and periodic (quarterly) monitoring of the post-treatment water and system will continue for a year.

7.1.4. Well/piezometer installation

The new monitoring wells (MW-21 and MW-22) and piezometer will be completed in accordance with the IRAW as soon as permits are obtained. After completion, ground water samples will be collected from each new well and piezometers. Field activities will be conducted in accordance with the Sampling and Analysis Plan and the HASP. The PADEP will be notified of the field activities schedule.

7.1.5. Stream assessment

Once the piezometer installation is complete, the stream assessment tasks will be completed including surface water sampling and stream level gauging. The ground water and stream hydraulic data will be evaluated to assess their hydraulic relationship. The piezometer and stream levels will be monitored during the hydraulic containment pilot test to further assess the effect of ground water pumping on flow to the stream and to evaluate the ground water - stream cutoff system for the Site.

7.1.6. Hydraulic containment/treatment system pilot testing

The system pilot test will be conducted once the well installations are completed, permits are authorized, and the necessary pilot test equipment is procured and installed. Pilot testing activities will be conducted in accordance with the Sampling & Analysis Plan and HASP. The PADEP will be notified prior to the initiation of pilot test activities. At the completion of pilot testing and data evaluation, and the Interim RAP Remedial Design Progress Report will be prepared and submitted to the PADEP.

7.1.7. Final interim system design/O&M

The final design of the interim ground water containment system will be completed based on the results of the pilot testing, including permits required; equipment design, procurement and installation; and system startup. An O&M Plan will be prepared for the startup period and long term

- Description of accidents involving personnel on-site.
- Records of field equipment malfunction and repair.
- Records of site visitations.
- Records of field equipment calibrations (or on field calibration form).
- Matrix type and sample description.
- Date and time of sample collection.
- Collector's sample identification number.
- Sample distribution (e.g., laboratory, etc.).
- Observations of sample collection environment, if required.
- Field measurements made (or on ground water sampling form/soil boring log).
- Sampler's name.
- Sample type (grab, duplicate and field blank).
- Source and type of preservatives used.
- Analysis to be performed.

6.11.2. Field forms

In addition to the field notebook(s), various field documentation forms will be completed to document activities and sampling field forms to be utilized will include:

- Field instrument calibration forms
- Ground water sampling forms
- Chain of custody records
- Boring log/well construction logs
- Well development form

6.12. Quality assurance project plan

An integral part of the Sampling & Analysis Plan for the IRAP is the Quality Assurance Project Plan (QAPP). The QAPP has been developed for the IRAP and is consistent with the field activities and sampling activities detailed in the Field Sampling Plan. The QAPP is presented in Appendix A.

6.13. Health and safety plan

O'Brien & Gere has developed a site-specific Health & Safety Plan (HASP) for the IRAP for the Site. The HASP is presented in Appendix B.

operation based on the interim system. After the startup period and initial monitoring is completed, and Interim RAP Progress Report, which will include a report on the final system design and the O&M Plan, will be prepared and submitted to the PADEP. The Site Sampling & Analysis Plan and HASP will be updated, as necessary.

7.2. Schedule

The implementation schedule for the ground water IRAW activities is presented in Figure 6. As shown, the implementation schedule consists of the following remaining major tasks as follows:

- Interim Final Design: This task includes permitting activities, extraction/monitoring/piezometer well installation, monthly hydraulic monitoring (initiated in January 1999), and the stream assessment. It is estimated this task will require 6 months (January to June 1999) for completion (excluding ongoing hydraulic monitoring).

- Remedial System Startup: This task includes pilot testing, equipment design, procurement and installation, and startup/evaluation activities. This task is estimated to be completed in 9 months.

- Operation & Maintenance (O&M): The O&M task includes weekly/monthly hydraulic monitoring, ground water and surface water sampling, periodic performance evaluation and progress reports. As shown in the attached schedule, O&M is projected to begin in April 2000.

8. References

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Table 1. *General Water Quality Characteristics Residential Water Treatment System (RWTS) (February 24, 1999).*

Parameter	Potable Water Sample - 54 Conestoga Road Residence Concentration (mg/L)
Hardness	232
Total Dissolved Solids	323
Total Suspended Solids	< 10
Iron	0.04
pH (s.u.)	7.34

Table 2. *Pilot Test Data Collection.*

Location	Parameter	Frequency
Extraction Wells	Total Pump Volume	Continuous
	Water Level	Continuous
	Flow Rate (instantaneous)	1 per hour
	VOCs	1 per 4 hours/1 per day[1]
	Dissolved Metals	1 per 4 hours/1 per day[1]
Monitoring Wells/Piezometers	Water Levels	Continuous (log time interval) for select wells, otherwise: 1 per hour (until stabilized) 1 per 4 hours (after stabilized)
Equalization Tank	Total VOCs	1 per day
	Total Organic Carbon	1 per day
	Iron, Total	1 per day
	Iron, Dissolved	1 per day
	Total Suspended Solids (TSS)	1 per day
	Total Dissolved Solids (TDS)	1 per day
	pH	1 per day
	Temperature	1 per day
		1 per day
Granular Activated Carbon[2] Unit #1 Effluent	Total VOCs	1 per day
	Total Organic Carbon	1 per day
	TDS	1 per day
	TSS	1 per day
Granular Activated Carbon[2] Unit #2 Effluent	Total VOCs	1 per day
	Total Organic Carbon	1 per day
	TDS	1 per day
	TSS	1 per day
	POTW Discharge Parameters (Table 5)	Once during pilot test

1. The sampling frequency will be adjusted after the first 24 hours of pumping, based on the system response
2. Metals include chromium, copper, nickel and zinc

Table 3. *Proposed Treatment System - Flow Weighted Average and Maximum VOC Influent Concentrations.*

Compound	Extraction Well (MW-21) (Near MW-3)		Extraction Well MW-9		Anticipated Treatment System Influent Concentrations	
	Average Concentration	Maximum Concentration	Average Concentration	Maximum Concentration	Average Concentration	Maximum Concentration
PCE	32.5	124	10.3	40.6	21.3	82.3
TCE	163586.3	680000	49663.2	107000	106624.8	393500.0
c-1,2-DCE	ND	ND	ND	ND	NA	NA
t-1,2-DCE	829.2	2620	465.4	1150	647.3	1885.0
1,1-DCE	221	613	62.8	116	142.0	364.5
Vinyl Chloride	ND	ND	5.8	14.4	2.9	7.2
1,1,2-TCA	ND	ND	ND	ND	NA	NA
1,1,1-TCA	4440.2	11700	922.3	1420	2681.3	6560.0
1,2-DCA	1.0	6.1	0.4	2.4	0.7	4.3
1,1-DCA	54.7	180	16.3	93.3	35.5	136.7
Chl. Ethane	ND	ND	ND	ND	NA	NA
Chloroform	19.7	118	0.7	4.3	10.2	61.2
1,4-DCB	ND	ND	ND	ND	NA	NA
Chlorobenzene	ND	ND	ND	ND	NA	NA
TCFM	15.4	92.5	ND	ND	7.7	46.3
DBCM	ND	ND	ND	ND	NA	NA
Bromoform	ND	ND	ND	ND	NA	NA
BDCM	ND	ND	1.2	5.3	0.6	2.7
Bromomethane	ND	ND	0.5	4.4	0.2	2.2
Total (Rounded)					110,000	404,000

Notes:

Concentrations are in μg/l
* - Assumes Extraction Wells operate at 30 gpm each for a treatment system total of 60 gpm
ND - Not Detected
NA - Not Applicable

Compound Abbreviations:

1,1-DCA = 1,1-Dichloroethane
1,2-DCA = 1,2-Dichloroethane
1,1,2-TCA = 1,1,2-Trichloroethane
1,1,1-TCA = 1,1,1-Trichloroethane
1,4-DCB = 1,4-Dichlorobenzene
c-1,2-DCE = cis-1,2-Dichloroethene
t-1,2-DCE = trans-1,2-Dichloroethene
1,1-DCE = 1,1-Dichloroethene
TCE = Trichloroethene
PCE = Tetrachloroethene
TCFM = Trichlorofluoromethane
DBCM = Dibromochloromethane
BDCM = Bromodichloromethane

Table 4. *General Water Quality Characteristics - Ground Water Treatment System.*

Parameter	**Monitoring Well MW-2 and MW-9 Concentrations (mg/l) (February 19, 1999)**
Alkalinity to pH 4.5	187 - 222
Total Dissolved Solids	294 - 365
Total Suspended Solids	< 10 - 16
Chemical Oxygen Demand (COD)	< 10 - 12.5
Biological Oxygen Demand (BOD)	< 2.0 - 4.0
pH (s.u.)	7.19 - 7.22
Iron	0.14 - 0.582
Total Organic Carbon (TOC)	1.1 - 1.3
Total Organic Halides (TOX)	1.1 - 5.2
Calcium	71.6
Magnesium	10.2

Table 5. *POTW Discharge Limits (Valley Forge Sewer Authority).*

Parameter	Local Limits (mg/l)	Sample Types
Arsenic - Total (As)	0.04	Composite
Cadmium - Total (Cd)	0.09	Composite
Chromium - Total (Cr)	6.0	Composite
Chromium - Hexavent (Cr**)	1.0	Composite
Copper - Total (Cu)	1.0	Composite
Cyanide - Total (CN)	0.26	Grab
Lead - Total (Pb)	0.10	Composite
Mercury - Total (Hg)	0.02	Composite
Molybdenum - Total (Mo)	Monitor Only	Composite
Nickel - Total (Ni)	0.90	Composite
PCBs - EPA Method 608	ND - Not Detected	Composite
*Phenolics - Total	Monitor Only	Composite
Selenium - Total (Se)	Monitor Only	Composite
Silver - Total (Ag)	0.08	Composite
Zinc - Total (Zn)	1.0	Composite
Oil & Grease - animal or vegetable origin	200	Grab
Oil & Grease - petroleum (TPH) or unknown origin	100	Grab
Ph (s.u.)	6.0 - 9.5 s.u.	Grab - field
Total Toxic Organics (TTO)	To Be Determined	Grab

Table 6. *Full Scale System Data Collection: Startup.*

Location	Parameter	Frequency
Extraction Wells	Total Pump Volume	Continuous
	Water Level	Continuous
	VOCs	24 Hours
	Dissolved Metals	24 Hours
Monitoring Wells	Water Level	Continuous/Daily
Equalization Tank	Total VOCs	1 per day
	Total Organic Carbon	1 per day
	Iron, Total	1 per week
	Iron, Dissolved	1 per week
	Total Suspended Solids (TSS)	1 per week
	Total Dissolved Solids (TDS)	1 per week
	pH	1 per day
	Temperature	1 per day
Air Stripper Effluent (Treated Ground Water)	Total VOCs	1 per day
	Total Organic Carbon	1 per day
	TDS	1 per day
	TSS	1 per day
	POTW Discharge Parameters (Table 5)	Once during startup
Air Stripper Air Exhaust	Total VOCs	1 per day
	Temperature	1 per day
	Air Flow Rate	1 per day
Air Scrubber Exhaust	Total VOCs	1 per day
	Temperature	1 per day
	Air Flow Rate	1 per day

Table 7. *Full Scale System Data Collection: Normal Operation.*

Location	Parameter	Frequency
Extraction Wells	Total Pump Volume	Continuous
	Water Level	Continuous
	VOCs	Monthly/Quarterly
	Dissolved Metals	Monthly/Quarterly
Monitoring Wells	Water Level	Monthly
	Total VOCs/Dissolved Metals	Quarterly
Equalization Tank	Total VOCs	1 per month
	Total Organic Carbon	1 per month
	Iron, Total	1 per month
	Iron, Dissolved	1 per month
	Total Suspended Solids (TSS)	1 per month
	Total Dissolved Solids (TDS)	1 per month
	pH	1 per month
	Temperature	1 per month
Air Stripper Effluent (Treated Ground Water)	Total VOCs	1 per month
	Total Organic Carbon	1 per month
	TDS	1 per month
	TSS	1 per month
	POTW Discharge Parameters (Table 5)	Once per quarter
Air Stripper Air Exhaust	Total VOCs	1 per month
	Temperature	1 per month
	Air Flow Rate	1 per month
Air Scrubber Exhaust	Total VOCs	1 per month
	Temperature	1 per month
	Air Flow Rate	1 per month

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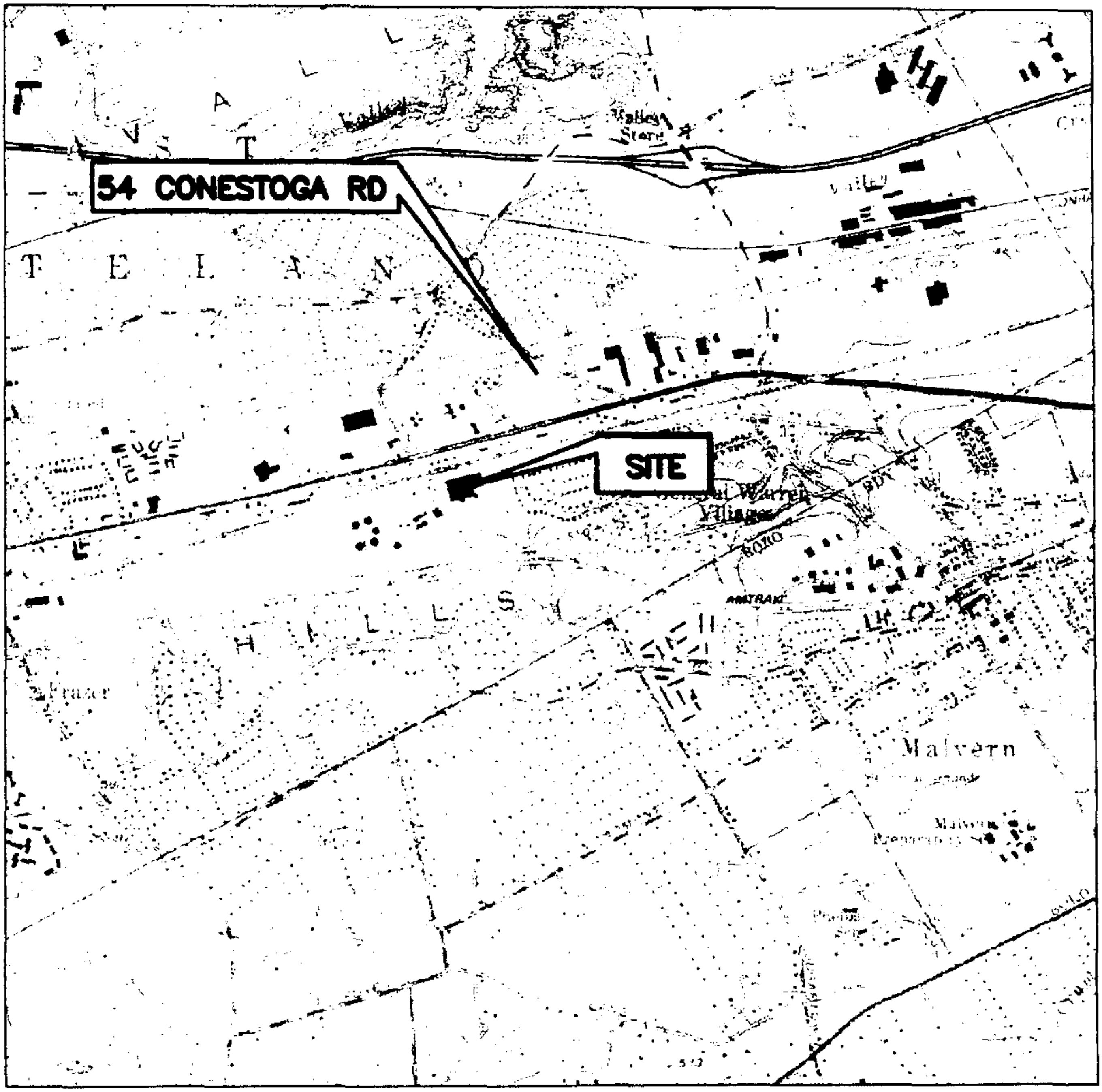
FIGURE 1



ADAPTED FROM USGS 7.5 MINUTE QUADRANGLE TITLED MALVERN, PA

BISHOP TUBE FACILITY
FRAZER, PENNSYLVANIA

SITE LOCATION MAP

STATE LOCATION MAP

0 2000 4000

23276-01
5/10/99

ENGINEERS INC.

PLOT DATE: 5/10/99

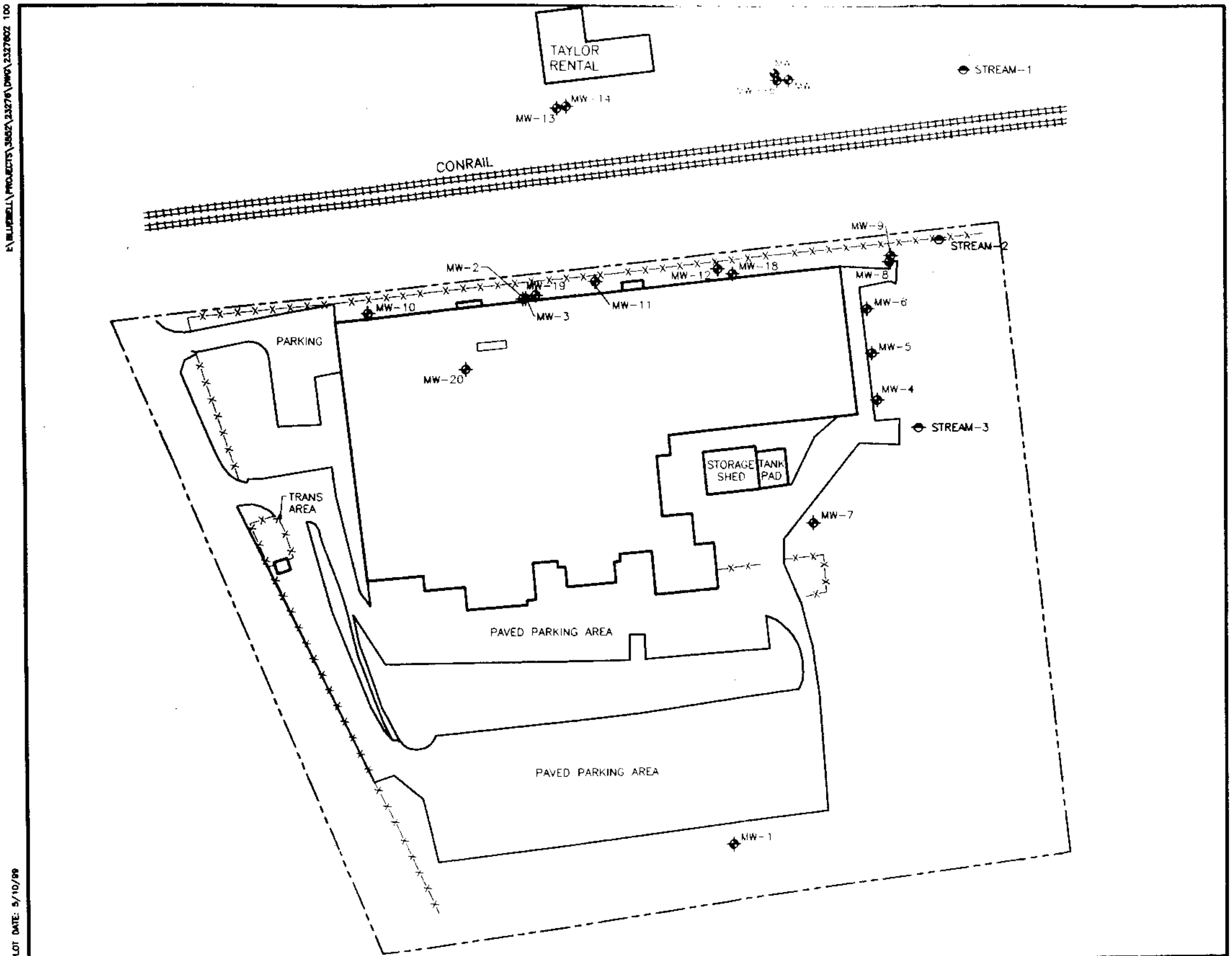


FIGURE 2

LEGEND

- EXIST. GROUND WATER MONITORING WELL
- STREAM SAMPLING LOCATION
- NEW GROUND WATER MONITORING WELL/ PIEZOMETER LOCATION
- STREAM
- FENCE LINE
- RAILROAD TRACKS

BISHOP TUBE SITE
FRAZER, PA.

IRAP WORK PLAN

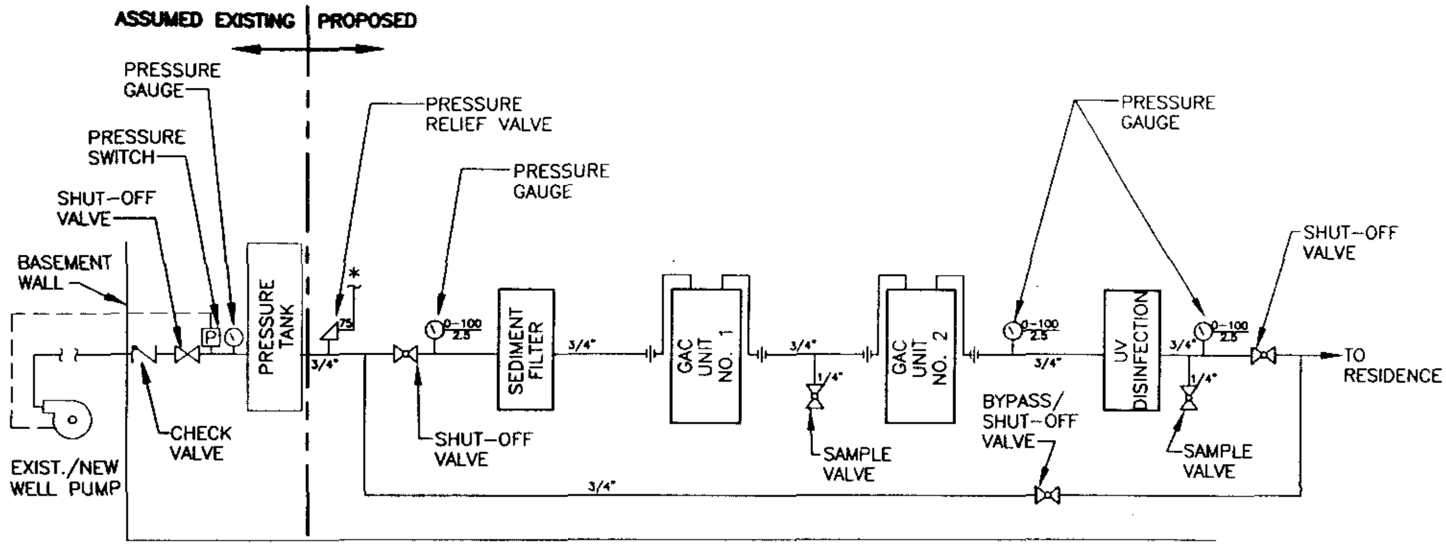
PROPOSED MONITORING WELL AND PIEZOMETER LOCATION PLAN

1"=100' 100 0 100

5/10/99
23276-02

O'BRIEN & GERE ENGINEERS INC

PLOT DATE: 5/10/99



ITEM	QUANTITY	VENDOR/PART NO.	DESCRIPTION
PIPING	N/A	N/A	3/4" TYPE "L" COPPER WATER TUBING WITH A MIN. BURSTING PRESSURE OF 3100 psi
SEDIMENT FILTER	1	WATTS/ MODEL NO. WHSS-2 OR EQUAL	SEDIMENT FILTER WITH 20 μ SEDIMENT CARTRIDGE
PRESSURE RELIEF VALVE	1	WATTS/ MODEL NO. 53 OR EQUAL	3/4" CONNECTION WITH 1/2" DRAIN; * 75 psi SETTING
PRESSURE GAUGE	3	ASHCROFT OR EQUAL	2 1/2"ø, 0-100 psi, BRONZE TUBE-GLYCERINE FILLED, METAL CASE, POLYCARBONATE WINDOW, 1/4" CONNECTION WITH WATTS SERIES B-6000 BRONZE BALL VALVE
1/4" SAMPLE VALVE	2	WATTS/ MODEL NO. B-6000 OR EQUAL	1/4" 2 PIECE BRONZE BALL VALVE WITH THREADED FITTING, 125 psi RATING
3/4" SHUT-OFF VALVE	3	WATTS/ MODEL NO. B-6000 OR EQUAL	3/4" BRONZE 2 PIECE BALL VALVE WITH THREADED FITTING, 125 psi RATING
GAC UNIT	2	CARBTROL/MODEL NO. HP-90 OR EQUAL	GRANULAR ACTIVATED CARBON UNIT
UV DISINFECTION UNIT	1	MASTER WATER CONDITIONER CO./MODEL NO. HI-MSV-10 OR EQUAL	ULTRAVIOLET STERILIZATION/DISINFECTION UNIT, 10 gpm RATING
UNIONS	4	NIBCO/MODEL NO. 633 OR EQUAL	3/4" COPPER UNION

FIGURE 3

NOTE:

NA = NOT APPLICABLE

GAC = GRANULAR ACTIVATED CARBON

UV = ULTRAVIOLET

* = PRESSURE RELIEF VALVE DRAIN DISCHARGED TO SUMP OR OUTSIDE WALL TO GROUND

INSTALLATION OF ALL EQUIPMENT IN ACCORDANCE WITH LOCAL PLUMBING CODES.

BISHOP TUBE SITE
FRAZER, PA.

IRAP WORK PLAN

RESIDENTIAL WELLHEAD TREATMENT SYSTEM (RWTS)

5/10/99
FILE NO: 23276-03

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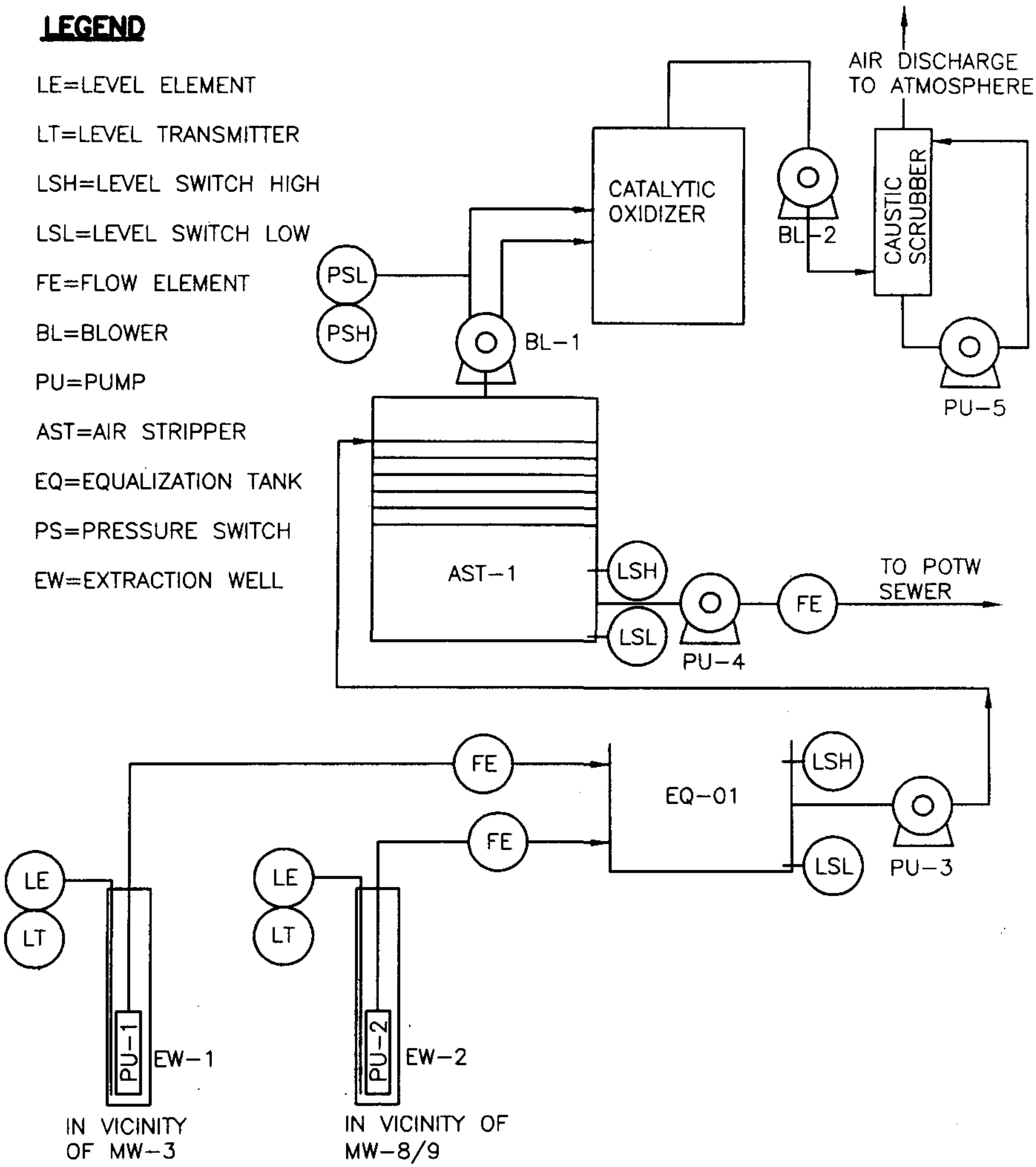
FIGURE 4



BISHOP TUBE SITE
FRAZER, PA
CONCEPTUAL PROCESS FLOW DIAGRAM
(WITH CATALYTIC OXIDIZER OFF GAS TREATMENT)

IRAP WORK PLAN

NOT TO SCALE

23276-04
DATE: 5/10/98

ENGINEERS INC.

PLOT DATE: 5/10/98

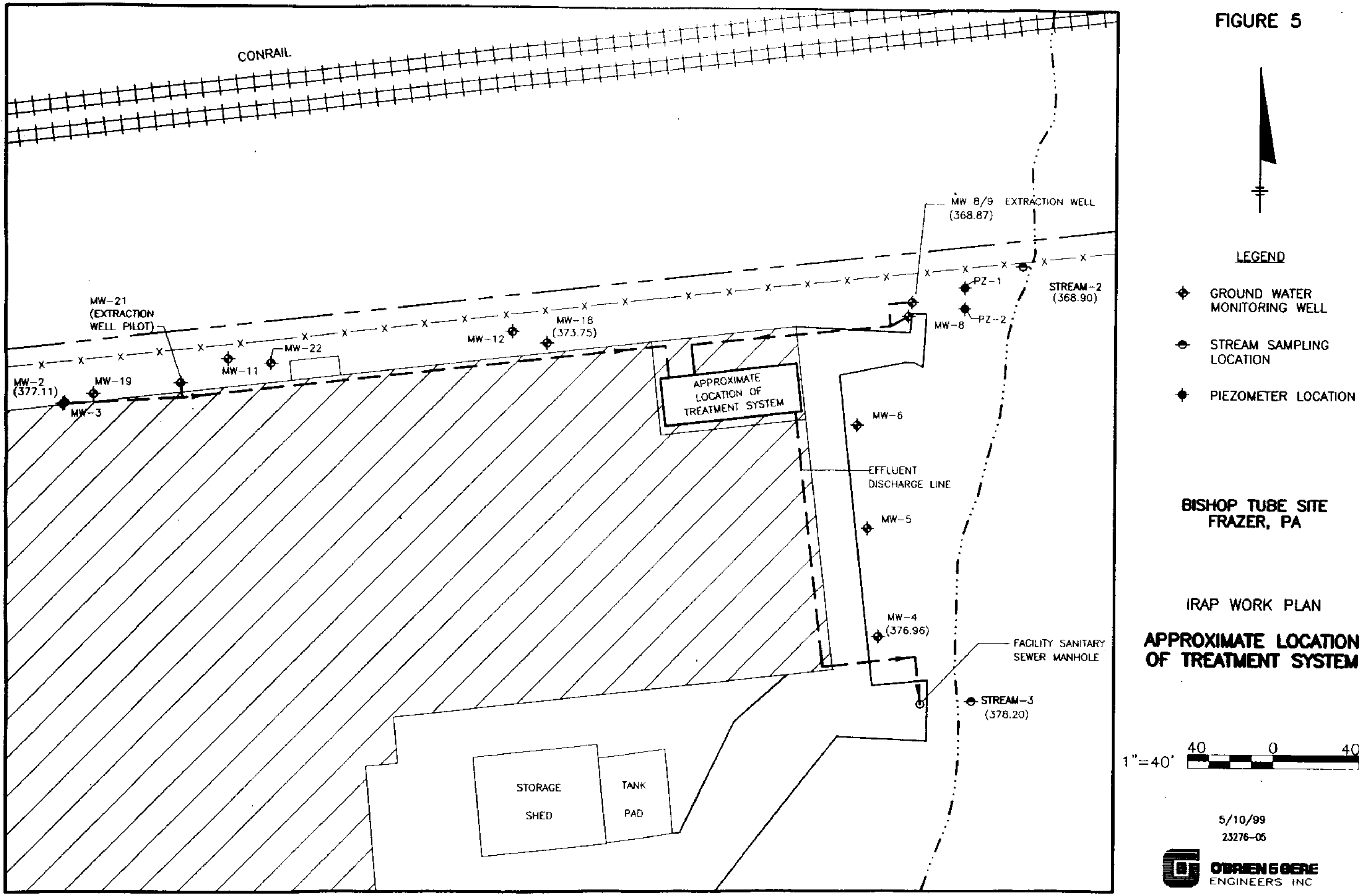


FIGURE 5

BISHOP TUBE SITE
FRAZER, PA

IRAP WORK PLAN

APPROXIMATE LOCATION OF TREATMENT SYSTEM

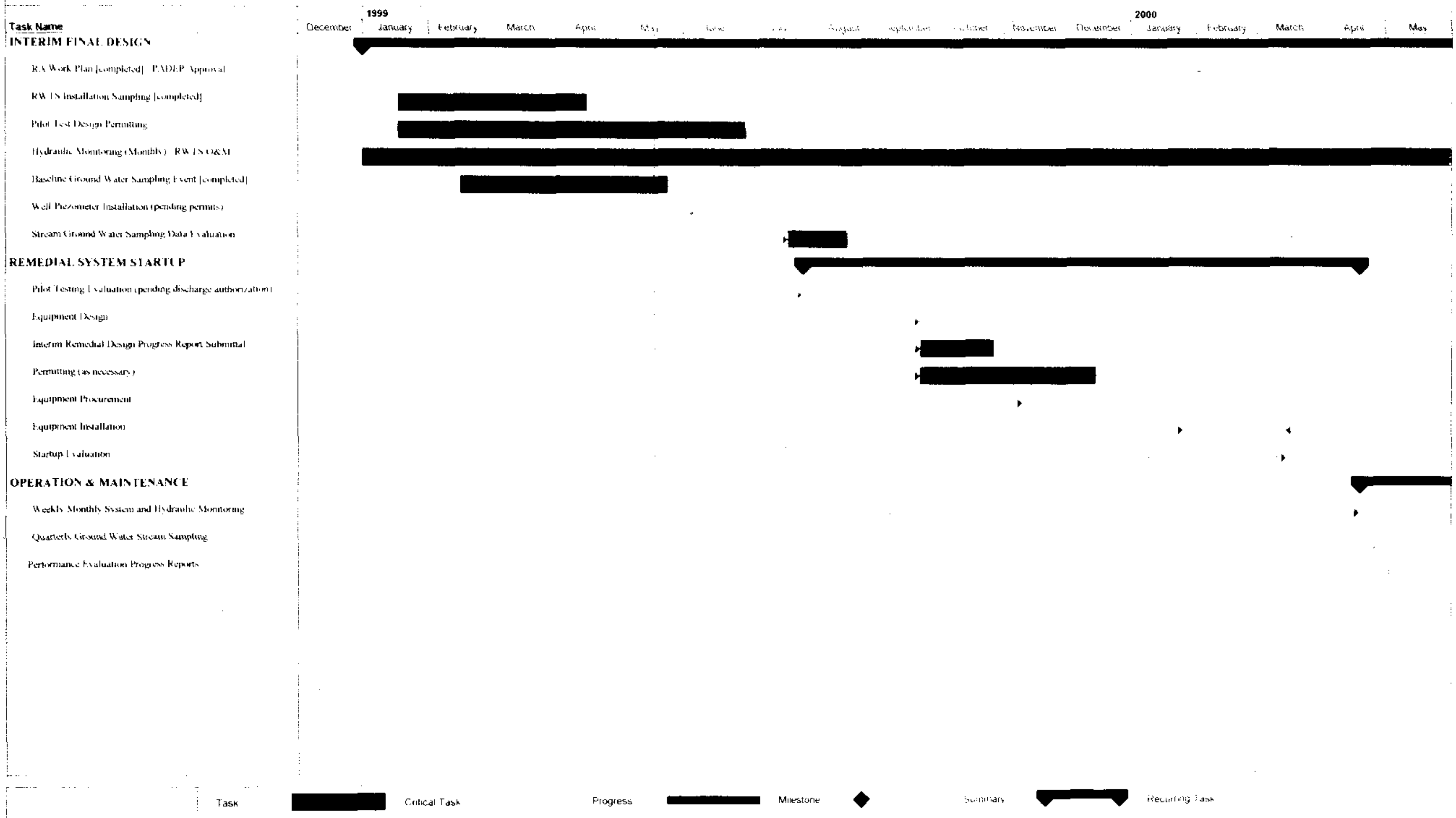
5/10/99
23276-05

O'BRIEN & GERE ENGINEERS INC

PLOT DATE: 5/10/99

FIGURE 6

INTERIM REMEDIAL ACTION PLAN WORKPLAN
IMPLEMENTATION SCHEDULE (updated 5-10-99)
BISHOP TUBE SITE



Quality Assurance Project Plan for the Bishop Tube Site

Christiana Metals Corporation
Frazer, Pennsylvania

May 1999

O'BRIEN & GERE ENGINEERS, INC.

3552/23276

Interim Remedial Action Work Plan Appendix A

Quality Assurance Project Plan

Christiana Metals Corporation
Frazer, Pennsylvania

May 1999

O'BRIEN & GERE ENGINEERS, INC.

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Gwynedd Hall, Suite 302
Blue Bell, Pennsylvania 19422

Contents

List of figures

List of tables

List of appendices

1. Introduction

This Quality Assurance Project Plan (QAPP) has been developed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of Christiana Metals Corporation for the Interim Remedial Action Program (IRAP) at the Bishop Tube Facility Site (Site) in Frazer, Pennsylvania. This QAPP provides quality assurance/quality control (QA/QC) criteria for work efforts associated with sampling and analysis of environmental media.

This document has been prepared utilizing the guidance provided in the United States Environmental Protection Agency's (USEPA's) *EPA Requirements For Quality Assurance Project Plans For Environmental Data Operations*, EPA QA/R-5 (USEPA 1994a) and USEPA's *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (USEPA 1980).

This QAPP will assist in generating data of a known and acceptable level of precision and accuracy. The QAPP provides information regarding the project description and personnel responsibilities, and sets forth specific procedures to be used during sampling of relevant environmental matrices, other field activities, and the analyses of data.

The following quality assurance topics are addressed in this plan:

- Project organization and responsibilities
- Project description
- Data quality objectives
- Project narrative
- Special training requirements
- Documentation
- Sampling design

- Sample handling and custody
- Analytical method requirements
- Quality control requirements
- Instrumentation/equipment testing and maintenance
- Calibration and frequency
- Inspection requirements for supplies
- Data acquisition requirements
- Data management
- Performance, system audits, and corrective actions
- QA reports to management
- Data review, validation and verification
- Data validation
- Reconciliation with user requirements

2. Project organization and responsibilities

2.1. Roles

While each person involved in the remedial action and in the generation of data is implicitly part of the QA program for the project, certain individuals have specifically designated responsibilities. Within O'Brien & Gere Engineers, these are the Project Officer, the Project Manager, Field Program Coordinator, QA Officer, the Data Validators, and the Environmental Technicians. STL-Envirotech of Edison, New Jersey will provide analytical services for the sampling activities performed at the site. Laboratory personnel with QA/QC responsibilities include the Laboratory QC Coordinators and Laboratory Sample Custodians.

2.2. Project officer

Dana Pizarro, P.E., of O'Brien & Gere will serve as the Project Officer. As such, he will be responsible for the overall completion of work. It will be his responsibility to provide for the allocation of staff and other resources required to complete the project within the specified schedule and budget.

2.3. Project manager

Tom Nowlan, P.E., of O'Brien & Gere will serve as the Project Manager. As such, he will have responsibility for the implementation and completion of the work associated with this Site. He will function as the Firm's principal client and regulatory contact for the project. He will manage the administrative aspects of the project, and will report to the Project Officer.

2.4. Technical program coordinator

Michael Kozar, P.G. of O'Brien & Gere will serve as the Technical Field Program Coordinator. As such, he will have responsibility for coordinating the technical aspects of the project and will also function as a client and regulatory contact for the project. The Field Program Coordinator will report to the Project Manager.

2.5. QA officer

Karen Storne of O'Brien & Gere will serve as the QA Officer (QAO). She will review project plans and revisions to such plans to maintain proper QA throughout the remedial action. In addition, the QAO will be responsible for performance and system audits, data processing activities, data processing QC, data quality review, corrective actions, and coordinating the QA/QC efforts between O'Brien & Gere and the laboratory. The QAO will report to the Project Manager.

2.6. Data validators

O'Brien & Gere Data Validators will be responsible for reviewing chemical data and validating laboratory analytical data. Validation reports will be submitted to the QAO for review. The QAO will have overall responsibility for data validation, and the data validators will report to the QAO.

2.7. Sampling personnel

Sampling tasks required by this remedial action will be conducted by experienced chemists, engineers, geologists, hydrogeologists, and/or environmental technicians. Their responsibilities will include the documentation of proper sample collection protocols, sample collection, equipment decontamination, and chain-of-custody documentation. The sampling personnel will report to the Field Program Coordinator.

2.8. Laboratory QC coordinator

Bianca Buckwalter of STL-Envirotech will serve as the Laboratory QC Coordinator. As such, she will be responsible for the individual laboratory's QA/QC activities associated with the project. The specific duties of the Laboratory QC Coordinator include determining whether analyses are conducted within the appropriate holding times and that laboratory custody procedures are followed. Moreover, the Laboratory QC Coordinator monitors daily precision and accuracy records, maintains detailed copies of all procedures, reschedules analyses based upon unacceptable data accuracy or precision, and identifies and implements corrective actions necessary to maintain QA standards.

The Laboratory QC Coordinator or her designee will conduct initial validations and assessments of analytical data results and report the findings directly to the QAO.

2.9. Laboratory sample custodian

Howard Schultze of STL-Envirotech will serve as the Laboratory Sample Custodian. As such, his responsibilities include verifying proper sample entry and sample handling procedures by laboratory personnel. The laboratory sample custodian will report to the laboratory QC Coordinators.

3. Project description

The Bishop Tube facility, located in Frazer, Chester County, Pennsylvania, is owned by Christiana Metals Corp. A detailed site description and an outline of the project activities, including ground water sampling, is provided in the *Site Characterization and Interim Remedial Action Plan, Bishop Tube Site, Frazer, Pennsylvania* (O'Brien & Gere, 1998) and this Workplan. The purpose of this QAPP is to provide data to support both qualitative and quantitative conclusions concerning the evaluation of the presence of chemical constituents which may have impacted ground water and other waters near the Site.

4. Data quality objectives

4.1. Objectives

Data quality objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. DQOs define the total acceptable uncertainty in the data for each specific activity conducted at the site. The uncertainty includes both sampling error and analytical error. Ideally, zero uncertainty is the intent. However, the variables associated with the process (field and laboratory) inherently contribute to the uncertainty of the data. It is the overall objective to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. The QA/QC requirements have been established such that there will be a high degree of confidence in the measurements.

The principle DQOs of this QAPP are to generate data of sufficient quality to support both qualitative and quantitative conclusions concerning the evaluation of the potential presence of chemical constituents which may have impacted ground water and well water at the Bishop Tube Facility Site. In order to achieve these DQOs, the process of data generation was designed to develop a body of analytical data of sufficient quality to be used to support conclusions made as a result of sampling and analytical activities at the site. Specific data quality requirements such as criteria for precision, accuracy, representativeness, completeness, comparability, and sensitivity are specified in this document.

Laboratory analyses and analytical levels will adhere to the guidelines described in USEPA's *Data Quality Objectives for Remedial Response Activities* (USEPA 1987). Analytical levels as defined in the guidance document USEPA's *Data Quality Objectives Process For Superfund, Interim Final Guidance* (USEPA 1993), are as follows:

- Screening Data: Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provide analyte identification and quantitation, although the quantitation may be relatively imprecise. At least 10% of the screening data are confirmed using analytical methods and QA/QC procedures and criteria associated with definitive data. Screening data without associated confirmation data are not considered to be data of known quality.

- Definitive Data: Definitive data are generated using rigorous analytical methods, such as EPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce tangible raw data in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

Table 4-1 on the following page contains sampling efforts, objectives, analyses, data uses, and analytical levels. The remainder of this QAPP describes the specific approaches that will be taken to achieve the required DQOs. To assess adherence to DQOs, O'Brien & Gere has developed the QA/QC program described in this QAPP. The following is a brief description of the data quality parameters addressed in the QAPP.

Precision describes the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements, that have been made in an identical manner, compared to their average value. Precision can be expressed in a variety of manners, including absolute methods such as deviation from the mean or median values, standard deviation and variance, or relative methods, such as relative deviation from the mean or median. The overall precision will be determined through the analysis of field duplicate and laboratory duplicate samples.

Table 4-1. *Sampling efforts, objectives, analyses, data uses, and analytical level.*

Sampling effort	Objective	Types of analysis	Data uses	Analytical level
Ground water sampling	Characterize the nature and extent of potential impact to the ground water.	VOCs *Metals Fluoride	Evaluate the presence of chemical constituents	Definitive Data
Water sampling	Characterize the nature and extent of potential impact to the ground water and stream.	field analyses including pH, Eh conductivity, turbidity, dissolved oxygen, and temperature	Evaluate the presence of chemical constituents	Definitive Data
Surface water (stream) sampling	Characterize the nature of potential impact to surface water and assess stream quality	VOCs, *metals, fluoride, TDS, TO, anions/cations	Evaluate the presence of chemical constituents	Definitive data
Water sampling (purge/decontamination fluids)	Characterization of the water generated during sampling/remediation activities.	SVOCs VOCs *Metals TSS/TDS **Metals TOX Oil & Grease	Evaluate discharge/disposal technique for the collected water	Definitive Data
Residential well water sampling	Characterize the nature of the well water before and after RWTS.	VOCs Total Plate Count	Evaluate the presence of chemical constituents	Definitive Data

Note:
VOCs indicate volatile organic compounds.
SVOCs indicate semivolatile organic compounds.
*Metals consist of chromium, copper, nickel, and zinc.
**Metals consist of iron and manganese.
# indicates that data generated by field analyses and for disposal characterization will not be data validated.
TOX indicates total organic halides
TDS indicates total dissolved solids.
TSS indicates total suspended solids.
TO indicates total organic carbon.
RWTS indicates residential wellhead treatment system.

Accuracy is defined as the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement comes to the true value, or actual concentration, the more accurate the measurement is. Accuracy is expressed in terms of absolute or relative error. Accuracy will be determined through analysis of spiked samples and the analysis of standards with known concentrations.

Representativeness refers to the degree to which a sample taken from a site accurately reflects the matrix at the site. It is a qualitative parameter which is most concerned with the design of the sampling program. Factors that should be considered in the determination of representativeness include appropriateness of sampling and analytical methodologies, representativeness of the selected media, and representativeness of the selected analytical procedures. Representativeness will be achieved by the use of procedures for the collection and preservation of samples as described in the methods and this QAPP.

Comparability refers to the use of consistent procedures, second source reference standards, reporting units, and standardized data format with document control. Adherence to standard procedures and the analysis of external source standard materials maximizes the probability that data generated from a particular method at a given laboratory can be validly compared to the data of another. This QAPP has been written to provide data which will be comparable to other data collected, as standard methods will be utilized for this remedial action.

Completeness refers to the process of obtaining the required data as outlined in the Work Plan. Completeness is also defined as the percentage of measurements judged to be useable. Samples for which the critical data points fail completeness objectives will require reanalysis of samples (within the specified holding times) until the DQOs are met. The completeness goal has been specified at 90% for this remedial action.

Sensitivity refers to a measurable concentration of an analyte which has an acceptable level of confidence. Method detection limits (MDLs) are the lowest concentration of an analyte that can be measured with 99% confidence that the analyte concentration is greater than zero. Practical quantitation limits (PQLs) are levels above the MDLs at which the laboratory has demonstrated the quantitation of analytes. The analytical methods associated with this project have MDLs and PQLs at sufficiently low levels to adequately assess the project DQOs.

4.2. Field sampling

The objective of field sampling procedures is to obtain samples that represent the environmental matrix being investigated. This will be accomplished through the use of proper sampling techniques and equipment. The field procedures and sampling equipment are detailed in the Field Sampling Plan (Section 6.1 of the Sampling and Analysis Plan).

4.3. Laboratory analyses

To obtain data of a quality sufficient to meet the project DQOs, the following methods will be performed:

- VOC analysis by gas chromatography and gas chromatography/mass spectrometry (GC/MS)
- SVOC analysis by GC/MS
- Metal analysis by inductively coupled plasma (ICP)
- Fluoride by potentiometric analysis
- TSS and TDS by gravimetric analysis
- TO by combustion or oxidation analysis
- TOX by carbon adsorption analysis
- Oil & Grease by spectrophotometric analysis
- Total (Standard) Plate Count
- Anion/Cations by Ion Chromatography

The specific methods, analytical QA/QC, and data reporting will adhere to the analytical methods described in Section 10 of this QAPP.

5. Project narrative

Field tasks for the Bishop Tube Facility Site (site) in Frazer, Pennsylvania include sampling of ground water, residential well water and stream water samples. The data will be used to evaluate the presence of chemical constituents which may have impacted these media from the Bishop Tube Facility Site.

Data usability with respect to the data quality objectives and data uses will be compared to the project requirements. In the event that the completeness objective of 90% is not achieved, samples will be recollected at the discretion of the Project Manager.

The analytical methods to be used in this remedial action are listed in Table 9-1 (Section 9). STL-Envirotech will perform the analytical services. The data results, which will be generated for data validation purposes, with the exception of waste characterization and field analyses, will be reported to O'Brien & Gere in Contract Laboratory Program (CLP)-like deliverable format, which is described in Appendix QAPP-A. With the exception of data generated from the disposal/discharge characterization and field analyses, full data validation will be performed on the analytical data.

At the discretion of the Project Manager, field and laboratory performance audits will be performed during the field program and during the laboratory analysis program. Corrective action procedures will be implemented based on unacceptable audit or validation results.

6. Documentation

Requested analytical data generated for the site, with the exception of data generated for disposal/discharge characterization and field analyses, will be reported to O'Brien & Gere in CLP-like deliverable format, which is described in Appendix QAPP-A and will contain the information required by this format. The laboratories will provide data packages within 3 weeks of receipt of the last sample at the laboratory. The field logs, data packages, and records will be included in the O'Brien & Gere project file. The project files will be archived at O'Brien & Gere for a period of 10 years.

7. Sample design

The objective of the sample collection program is to obtain environmental media of sufficient quality to support both qualitative and quantitative information as to the identity, location, and amount of constituents of concern in the water samples collected.

8. Sample handling and custody

8.1. Sample preparation and preservation

Immediately after collection, samples will be transferred to properly labeled sample containers and properly preserved. Table 8-1, included at the end of this section, lists the proper sample containers, volume requirements, and preservations. Samples requiring refrigeration for preservation will be promptly transferred to coolers packed with wet ice and/or ice packs. Samples will be shipped or transported within 48 hours of being collected and will arrive at the laboratory no later than 72 hours after sample collection. Proper chain-of-custody documentation will be maintained as discussed in this section of the QAPP. Samples will be extracted, digested and analyzed within the holding times specified in Table 8-1.

8.2. Sample custody procedures

Chain-of-custody procedures will be instituted and followed throughout the sampling activities at the site. These procedures include field custody, laboratory custody, and evidence files. Samples are physical evidence and will be handled according to strict chain-of-custody protocols. The QAO must be prepared to produce documentation that traces the samples from the field to the laboratory and through analyses. The USEPA has defined custody of evidence as follows:

- In actual possession
- In view after being in physical possession
- In a locked laboratory
- In a secure, restricted area.

QA measures for this project will begin with the sample containers. Pre-cleaned sample containers will be purchased from a USEPA-certified manufacturer (I-Chem 200 or equivalent).

Chain-of-custody records will be kept starting in the field when sample collection is completed. In the field log book, samplers will note climatic data and equipment employed during collection. Physical characteristics of the sample, date, time of day, sample location, and abnormalities noted during sampling will be recorded in the field log book.

The field sampler will indicate the sample identification number, date, time, sample matrix, sample type (*i.e.*, grab or composite), number of containers and the analysis requested on the appropriate chain-of-custody form. The chain-of-custody form will be signed and placed in a sealed ziploc bag in the cooler. An example chain-of-custody form is included as Figure 8-1. The shipping container will be closed, and two paper or plastic seals will be affixed to the latch and lid (only if the samples are shipped via overnight courier) and the field sampler will initial the seal. The seals must be broken to open the cooler and will indicate tampering if the seal is broken before receipt at the laboratory.

The cooler will be shipped via an overnight delivery service or hand delivered to the laboratory. When the samples arrive at the laboratory, the sample custodian will, after inspecting the contents of the sample coolers, sign the chain of custody and note the cooler temperature on the chain of custody. If shipped, the courier's airbill will be attached to the chain of custody and the airbill number will be written on the chain-of-custody form. If the cooler arrives at the laboratory after hours, an external chain-of-custody will be properly filled out and will accompany the cooler until the laboratory receives the cooler. An example external chain-of-custody is included in Figure 8-2.

The sample custodian's duties and responsibilities upon sample receipt will be to:

- Document receipt of samples

- Inspect sample shipping containers for the presence or absence of custody seals (only if shipped via overnight courier) and for container integrity

- Sign the appropriate forms or documents, verify and record the agreement or disagreement of information on sample documents and, if there are discrepancies, record the problem and notify the QAO

- Label sample with laboratory sample number

- Place samples in secure, limited-access storage.

At the laboratory, the analysts will be required to log samples and extracts in and out of storage as the analysis proceeds. Samples and extracts will be returned to secure storage at the close of business. Written records will be kept of each time the sample or extract changes hands. Care must be exercised to properly complete, date, and sign items needed to generate data. Copies of the following will be stored for incorporation into the sample file:

- Documentation of the preparation and analysis of samples, including copies of the analyst's notebooks

- Bench sheets, graphs, computer printouts, chromatograms, and mass spectra, as applicable

- Copies of QA/QC data

- Instrument logs showing the date, time, and identity of the analyst

- Analytical tracking forms that record the date, time, and identity of the analyst for each step of the sample preparation, extraction, and analysis.

Upon completion of the analyses, the QAO or his designee will begin assimilating the field and laboratory notes. In this way, the file for the samples will be generated. The final file for the sample will consist of the following:

- Laboratory data packages, including summary and raw data from the analysis of environmental and QC samples, chromatograms, mass spectra, calibration data, work sheets, sample preparation logs

- Chain-of-custody records.

Table 8-1. *Field sampling summary*

Parameter (critical method)	Matrix	Sample containers and volumes	Preservation	Holding times	No. of Environ-mental Samples	QC sample frequency			
						Field duplicate	Trip blank	MS/MSD	Equip. blank#
VOCs (USEPA Method 5030B/8260B)[1]	Ground water/surface water	2-40 milliliter glass vials with Teflon® lined septum caps	4°C pH<2 FC	14 days from collection	23	one per 20 samples	1 ea. per cooler with VOC samples	one per 20 samples	one per sampling event as required.
VOCs (USEPA Method 524.2, Revision 4)[3]	Residential well water	2-40 milliliter glass vials with Teflon® lined septum caps	4°C pH<2 FC	14 days from collection	1	one per 20 samples	1 ea. per cooler with VOC samples	one per 20 samples	one per sampling event as required.
SVOCs (USEPA Method 3520C/8270C)[1]	Ground water for disposal/discharg e characterization	1-one liter amber glass container with Teflon® lined screw caps	4°C	7 days from collection to extraction; 40 days from extraction to analysis	1	NA	NA	NA	NA

Table 8-1. *Field sampling summary*

Parameter (critical method)	Matrix	Sample containers and volumes	Preservation	Holding times	No. of Environ-mental Samples	QC sample frequency			
						Field duplicate	Trip blank	MS/MSD	Equip. blank#
*Metals (USEPA Method 3005A/6010B)[1]	Ground water/surface water	1-250 or 500 milliliter plastic bottle	HNO_3 to pH<2, 4°C	6 months	23	one per 20 samples	NA	one per 20 samples	one per sampling event as required.
**Metals (USEPA Method 3005A/6010B)[1]	Ground water for discharge/disposa l characterization	1-250 or 500 milliliter plastic bottle	HNO_3 to pH<2, 4°C	6 months	1	NA	NA	NA	NA
*Metals (USEPA Method 3005A/6010B)[1]	Ground water for discharge/disposa l characterization	1-250 or 500 milliliter plastic bottle	HNO_3 to pH<2, 4°C	6 months	1	NA	NA	NA	NA
Fluoride (USEPA Method 340.2)[2]	Ground water/surface water	1-250 or 500 milliliter plastic bottle	4°C	28 days	23	one per 20 samples	NA	one per 20 samples	one per sampling event as required.
Anions Scan (USEPA 300.0)	Surface water/ground water	1-50 milliliter plastic or glass bottle	4°C	28 days	3	NA	NA	NA	NA
Cations Scan (USEPA 300.7)	Surface water/ground water	1-100 milliliter plastic or glass bottle	4°C	28 days	3	NA	NA	NA	NA

Table 8-1. *Field sampling summary*

Parameter (critical method)	Matrix	Sample containers and volumes	Preservation	Holding times	No. of Environ-mental Samples	QC sample frequency			
						Field duplicate	Trip blank	MS/MSD	Equip. blank#
Total Organic Halides (TOX) (USEPA Method 9020B)[1]	Ground water for discharge/disposal characterization	8 ounce glass bottle with Teflon® lined screw caps	H2SO4 to pH<2, 4°C	28 days	1	NA	NA	NA	NA
Total organic carbon (USEPA Method 415.1)[2]	Surface water/ground water	1-250 or 500 milliliter plastic bottle	H_2SO_4 to pH<2, 4°C	28 days	1	NA	NA	NA	NA
Total suspended solids (USEPA Method 160.1)[2]	Ground water for discharge/disposal characterization	1-250 or 500 milliliter plastic bottle	4°C	7 days	1	NA	NA	NA	NA
Total dissolved solids (USEPA Method 160.2)[2]	Surface water/ground water	1-250 or 500 milliliter plastic bottle	4°C	7 days	1	NA	NA	NA	NA
Standard plate count (USEPA Method 9215)	Residential well water	10 milliliter plastic (sterile)	$Na_2S_20_2$ 4°C	24 hours	1	NA	NA	NA	NA
Oil & Grease (USEPA Method 413.2)[2]	Ground water for discharge/disposal characterization	1 quart glass with 1 milliliter	H_2SO_4 to pH<2, 4°C	28 days	TBD	NA	NA	NA	NA

Table 8-1. *Field sampling summary*

Parameter (critical method)	Matrix	Sample containers and volumes	Preservation	Holding times	No. of Environ-mental Samples	QC sample frequency			
						Field duplicate	Trip blank	MS/MSD	Equip. blank#

NOTES:

VOCs indicate volatile organic compounds.
SVOCs indicate semivolatile organic compounds.
#Equipment blank is not required if disposable equipment is used.
*Metals consist of chromium, copper, nickel, and zinc.
**Metals consist of iron and manganese.
1 - USEPA. 1996. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846*, 3rd Edition. Washington D.C.
Equip. indicates equipment.
2 - USEPA. 1983. *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, Cincinnati, Ohio.
3 - USEPA. 1992. *Methods for the Determination of Organic Compounds In Drinking Water*, EPA-600/R-92/129, Cincinnati, Ohio.
FC indicates that if free or residual chlorine is present in samples, it must be removed by the appropriate addition of ascorbic acid or $Na_2S_2O_3$ as required by the method.
OA indicates that if oxidizing agents are present, add 5 ml 0.1N $NaAsO_2$ per liter and 0.6 g of ascorbic acid per liter.
MS/MSD indicates matrix spike/matrix spike duplicate sample.
NA indicates not applicable.
TBD indicates that the number of environmental samples will be determined at a later date.

Figure 8-1. ***Example chain-of-custody***

Project Name:____________________
Project No. ________________Sheet ___ of ___

Office: ____________________

Address:____________________

Phone: ____________________

CHAIN OF CUSTODY

Cooler Temperature ________________

CLIENT: LOCATION:			COLLECTED BY: (Signature)			
SAMPLE DESCRIPTION/LOCATION	Date	Time	Sample Matrix[1]	Sample Type[2]	No. of Containers	ANALYSIS REQUESTED/COMMENTS[3]

[1] Matrix = Ground water, surface water, sediment, etc [2]Type = grab, composite [3] VOC - 524.2

Relinquished	Date	Time	Received	Date	Time
Relinquished by:__________ of:__________			Received by:__________ of:__________		
Relinquished by:__________ of:__________	Date	Time	Received by:__________ of:__________	Date	Time
Use this space if shipped via courier (e.g., Fed Ex) Relinquished by:__________ of:__________	Date	Time	Courier Name and Airbill Number:__________ ***Attach delivery/courier receipt to Chain of Custody**	Date	Time
Relinquished by:__________ of:__________	Date	Time	Received by:__________ of:__________	Date	Time

Figure 8-2. ***Example external chain-of-custody***

LABORATORY CASE FILE FORM

PROGRAM INFORMATION

Client: Div. Ref. No.

Program:

Custody Seal: _____ Intact _____ Not Intact _____ NA

AFTER HOURS CUSTODY

RELINQUISHED BY:	DATE	TIME	RECEIVED BY SECURITY GUARD:	DATE	TIME
RELINQUISHED BY SECURITY GUARD TO COOLER:	DATE	TIME	RECEIVED BY SAMPLE CUSTODIAN:	DATE	TIME

COMMENTS/DISCREPANCY:

RESOLUTION/CLIENT COMMENT:

Signed:

Date: QA/QC Approval:

Signed: ____________
Date: ____________

LABORATORY CASE FILE FORM

Signed: Project Manager Approval:

Date: QA/QC Approval:

9. Analytical method requirements

9.1. Analytical methods

The analytical methods utilized in this project are presented in Table 9-1. The laboratories will utilize the analytical methods and the quality control requirements provided in Tables 9-1 through 9-4 to analyze samples for this project. In the event of an analytical system failure, the Laboratory QC Coordinator will identify the situation and provide corrective action guidance. The O'Brien & Gere QAO will be notified and the situation will be documented in the data package non-conformance summary by the laboratory.

Interferences will be identified and documented. The laboratory will utilize appropriate screening techniques for samples suspected to contain matrix interference or high concentrations of analytes of concern. Samples may be diluted only if analytes of concern generate responses in excess of the linear range of the instrument or if significant matrix interference is present in the samples. If dilutions are performed and significant interference is not present, the samples will be reanalyzed undiluted. When matrix interferences are present, samples will be cleaned up during the extraction/sample preparation process using appropriate methods. The clean-up, extraction and sample preparation methods must be listed in the data package. If the laboratory has taken appropriate actions and matrix interferences prevent the laboratory from achieving the specified detection limits, the QAO will be contacted and the situation discussed. The Laboratory QC Coordinator will document samples analyzed at a dilution, reasons for the dilution, and that the laboratory demonstrated good analytical practices in order to achieve the specified detection limits.

Table 9-1. *Analytical methods for parameters*

Sample Type	Parameter	Analytical method	Reference
Ground water, surface water	VOCs	USEPA Method 5030B/8260B	1
Residential well water	VOCs	USEPA Method 524.2	3
Ground water for disposal/discharge characterization	SVOCs	USEPA Method 3520C/8270C	1
Ground water, surface water, and ground water for disposal/discharge characterization	Metals	USEPA Method 3005A/6010B	1
Ground water, surface water	Fluoride	USEPA Method 340.2	2
Ground water for disposal/discharge characterization	Total Organic Halides (TOX)	USEPA Method 9020B	1
Ground water for disposal/discharge characterization	Oil & Grease	USEPA Method 413.2	2
Surface water/ground water	Total Organic Carbon (TO)	USEPA Method 415.1	2
Ground water discharge/disposal characterization	Total Suspended Solids (TSS)	USEPA Method 160.1	2
Surface water/ground water	Total Dissolved Solids (TDS)	USEPA Method 160.2	2
Residential well water	Total Plate Count	USEPA Method 9215	"Std Method" 18th Ed.
Surface water/ground water	Cations	USEPA 300.7	2
Surface water/ground water	Anion Scan	USEPA 300.0	2

NOTES:
VOCs indicate volatile organic compounds
SVOCs indicate semivolatile organic compounds
1 - USEPA. 1996. *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846*, 3rd Edition. Washington D.C.
2 - USEPA. 1983. *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, Cincinnati, Ohio.
3 - USEPA. 1992. *Methods for the Determination of Organic Compounds In Drinking Water*, EPA-600/R-92/129, Cincinnati, Ohio.

9.2. Detection limits

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The PQL is the lowest concentration that can be reliably quantified within specified limits of precision and accuracy during routine laboratory operations. The analytical methods associated with this project have MDLs and RLs at sufficiently low levels to adequately assess the project DQOs. Tables 9-2a, 9-2b, 93 and 9-4 list typical STL-Envirotech MDLs and PQLs for the ground water sampling (with the exception of the samples collected for disposal/discharge characterization) and residential well sampling efforts to be used as reference during this remedial action.

Table 9-2a. *USEPA methods, 340.2 (fluoride), 415.1 (TO), 160.1 (TSS), 160.2 (TDS), 300.7 (anions), 300.0 (cations) detection limits.*

Analyte	Water (mg/L)	
	MDLs	**PQL**
fluoride	0.006	0.1
TO	0.80	1.0
TSS	4.75	10.0
TDS	2.4	10.0
anions/cations	TBD	TBD

Note:
MDL indicates method detection limit for STL-Envirotech
PQL indicates practical quantitation limits for STL- Envirotech
TBD - to be determined

Table 9-2b. *USEPA method 6010 (metals) detection limits.*

Analyte	Water (µg/L)	
	IDLs	PQL
chromium	1.039	1.60
copper	0.610	3.70
nickel	1.215	1.60
zinc	0.832	5.80
iron	18.705	39.20
magnesium	10.484	41.60

Note:
IDL indicates method detection limit for STL-Envirotech
PQL indicates practical quantitation limits for STL- Envirotech

Table 9-3. ***USEPA method 8260B detection limits***

Compound	Water ($\mu g/L$)	
	MDLs	PQLs
benzene	0.21	1.0
bromodichloromethane	0.13	1.0
bromoform	0.21	4.0
bromomethane	0.42	5.0
carbon tetrachloride	0.16	2.0
chlorobenzene	0.16	5.0
chloroethane	0.32	5.0
2-chloroethyl vinyl ether	0.64	5.0
chloroform	0.20	5.0
chloromethane	0.36	5.0
dibromochloromethane	0.12	5.0
1,1-dichloroethane	0.16	5.0
1,2-dichloroethane	0.29	2.0
1,1-dichloroethene	0.21	2.0
cis-1,2-dichloroethene	0.23	5.0
trans-1,2-dichloroethene	0.16	5.0
1,2-dichloropropane	0.18	1.0
cis-1,3-dichloropropene	0.13	5.0
trans-1,3-dichloropropene	0.17	5.0
ethylbenzene	0.12	4.0
methylene chloride	0.26	3.0
1,1,2,2-tetrachloroethane	0.20	1.0
tetrachloroethene	0.22	1.0
toluene	0.20	5.0
1,1,1-trichloroethane	0.27	5.0
1,1,2-trichloroethane	0.29	3.0
trichloroethene	0.14	1.0
trichlorofluoromethane	0.24	5.0
vinyl chloride	0.29	5.0
xylenes (total)	0.64	5.0

Note:
MDL indicates method detection limit for STL-Envirotech
PQL indicates practical quantitation limits for STL-Envirotech

Table 9-4. ***USEPA method 524.2 detection limits***

Compound	Water (μg/L)	
	MDLs	PQLs
benzene	0.09	0.5
bromobenzene	0.08	0.5
bromochloromethane	0.07	0.5
bromodichloromethane	0.10	0.5
bromoform	0.14	0.5
bromomethane	0.13	0.5
n-butylbenzene	0.08	0.5
sec-butylbenzene	0.09	0.5
tert-butylbenzene	0.10	0.5
carbon tetrachloride	0.11	0.5
chlorobenzene	0.07	0.5
chloroethane	0.16	0.5
chloroform	0.10	0.5
chloromethane	0.10	0.5
2-chlorotoluene	0.09	0.5
4-chlorotoluene	0.18	0.5
dibromochloromethane	0.16	0.5
1,2-dibromo-3-	0.31	0.5
1,2-dibromoethane	0.14	0.5
dibromomethane	0.13	0.5
1,2-dichlorobenzene	0.11	0.5
1,3-dichlorobenzene	0.13	0.5
1,4-dichlorobenzene	0.14	0.5
dichlorodifluoromethane	0.09	0.5
1,1-dichloroethane	0.11	0.5
1,2-dichloroethane	0.15	0.5
1,1-dichloroethene	0.10	0.5
cis-1,2-dichloroethene	0.09	0.5
trans-1,2-dichloroethene	0.08	0.5
1,2-dichloropropane	0.09	0.5
1,3-dichloropropane	0.15	0.5
2,2-dichloropropane	0.23	0.5
1,1-dichloropropene	0.08	0.5

Table 9-4. *USEPA method 524.2 detection limits*

Compound	Water (µg/L)	
	MDLs	PQLs
cis-1,3-dichloropropene	0.12	0.5
trans-1,3-dichloropropene	0.13	0.5
ethylbenzene	0.09	0.5
hexachlorobutadiene	0.15	0.5
isopropylbenzene	0.12	0.5
p-isopropyltoluene	0.08	0.5
methylene chloride	0.16	0.5
naphthalene	0.10	0.5
n-propylbenzene	0.11	0.5
styrene	0.15	0.5
1,1,1,2-tetrachloroethane	0.12	0.5
1,1,2,2-tetrachloroethane	0.23	0.5
tetrachloroethene	0.11	0.5
toluene	0.07	0.5
1,2,3-trichlorobenzene	0.24	0.5
1,2,4-trichlorobenzene	0.20	0.5
1,1,1-trichloroethane	0.11	0.5
1,1,2-trichloroethane	0.16	0.5
trichloroethene	0.08	0.5
trichlorofluoromethane	0.21	0.5
1,2,3-trichloropropane	0.25	0.5
1,2,4-trimethylbenzene	0.13	0.5
1,3,5-trimethylbenzene	0.10	0.5
vinyl chloride	0.10	0.5
Xylenes (total)	0.25	0.5

Note:
NA indicates not applicable.
MDL indicates method detection limit for STL-Envirotech
PQL indicates practical quantitation limits for STL-Envirotech

10. Quality control requirements

10.1. Background

The overall effectiveness of a quality control program depends upon operating in the field and laboratory according to a program that systematically ensures the precision and accuracy of analyses by detecting errors and preventing their recurrence or measuring the degree of error inherent in the methods applied. The following sections describe the QA/QC checks that will be utilized in the laboratory and the field during sampling activities at the site.

10.2. Laboratory QA/QC checks

10.2.1. Summary

Tables 10-1 through 10-3 summarize the laboratory quality control checks, frequency of analysis, control limits, and laboratory corrective actions by analytical method. A brief description of laboratory QA/QC analyses are contained in the following subsections.

10.2.2. GC/MS tuning

Tuning and performance criteria are established to verify mass resolution, identification, and instrument sensitivity. These criteria are not sample specific; conformance is determined using standard materials. Therefore, these criteria should be met in all circumstances.

10.2.3. Calibration

Compliance requirements for satisfactory instrument calibration are established to verify that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of analysis, and continuing calibration and performance checks document satisfactory maintenance and adjustment of the instrument on a day-to-day basis.

10.2.4. Blanks

Several types of blanks will be analyzed by the laboratory. Corrective action procedures will be implemented for blank analyses if target compounds are detected at concentrations greater than the MDL or the IDL (where applicable). The criteria for evaluation of blanks apply to any blank associated with a group of samples. If problems with a blank exist, data associated with the project must be carefully evaluated to determine whether or not there is an inherent variability in the data for the project, or if the problem is an isolated occurrence not affecting other data.

A reagent blank consists of laboratory distilled and/or deionized water and any reagents added to a sample during analysis only, or straight solvent. This type of sample is analyzed to evaluate whether contamination is occurring during the analysis of the sample. A reagent blank is usually analyzed following highly contaminated samples to assess the potential for cross-contamination during analysis.

A method blank is a water or soil blank which undergoes the preparation procedures applied to a sample *(i.e.*, extraction, digestion, clean-up). These samples are analyzed to examine whether sample preparation, clean-up, and analysis techniques result in sample contamination. The laboratory will prepare and analyze a method blank with each group of twenty samples or less of similar matrix that are extracted, digested, or analyzed at the same time.

10.2.5. Internal standards performance

Internal standards, which are compounds not found in environmental samples, will be spiked into blanks, samples, MS/MSDs, and laboratory control samples (LCSs) at the time of sample preparation or analysis. Internal standards must meet retention time and performance criteria specified in the analytical method or the sample will be reanalyzed.

10.2.6. Surrogate recovery

Accuracy and matrix biases for individual samples are monitored for organic analyses using surrogate additions. Surrogates are compounds similar in nature to the target analytes which are spiked into environmental samples, blanks, and quality control samples prior to sample preparation for organic analyses. The evaluation of the results of these surrogate spikes is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the review and validation of data based on specific sample results is frequently subjective. Surrogates must meet performance criteria or the sample will be reanalyzed.

10.2.7. Laboratory control samples/laboratory fortified blank

Laboratory control samples (LCSs) and laboratory fortified blanks (LFBs) are standard solutions that consist of known concentrations of the target analytes spiked into laboratory distilled water or a clean sand. They are prepared or purchased from a certified manufacturer from a source independent from the calibration standards to provide an independent verification of the calibration procedure. They are spiked with target analytes. These QC samples are then prepared and analyzed following the same procedures employed for environmental sample analysis to assess method accuracy independently of sample matrix effects. The laboratory will prepare and analyze a LCS or a LFB with each group of twenty samples or less of similar matrix that are extracted, digested, or analyzed at the same time. Percent recoveries will be evaluated to assess the efficiency of preparation and analysis method independent of environmental sample matrix effects. LCSs and LFBs must meet performance criteria or the solutions will be reanalyzed.

10.2.8. Matrix spike/matrix spike duplicate or laboratory duplicate samples/laboratory fortified sample matrix/laboratory fortified sample matrix duplicate

Matrix spike/matrix spike duplicate or laboratory duplicate analyses will be performed on environmental samples at a frequency of one per sample matrix and every twenty samples or less of similar matrix. Laboratory fortified sample matrix/laboratory fortified sample matrix duplicate (LFM/LFMD) samples will be performed in the event that internal standard or surrogate recoveries fail to meet criteria. Whenever possible MS/MSD/laboratory duplicate/LFM/LFMD samples will be prepared and analyzed within the same batch as the environmental samples. MS/MSD and LFM/LFMD samples will be spiked at the laboratory with target analytes. MS/MSD/laboratory duplicate/LFM/LFMD data are generated to determine precision and accuracy of the analytical method with respect to sample matrices.

10.2.9. Compound identification and quantitation

The objective of the qualitative criteria is to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not) or a false negative (not reporting a compound that is present). The identification criteria can be applied much more easily in detecting false positives than false negatives. Negatives, or non-detected compounds, on the other hand represent an absence of data and are, therefore, much more difficult to assess. The objective for quantitative requirements is to maximize the accuracy of data and sensitivity of the instrument. Samples should be analyzed undiluted to maximize sensitivity. Samples must be re-analyzed at the appropriate dilution when concentrations exceed the linear calibration range to maximize accuracy. If matrix interference is present in semivolatile samples, an appropriate clean-up technique should be employed and the sample re-analyzed. For inorganic analyses, interferences must be monitored and corrected for according to the techniques described in the appropriate method.

10.3. Field QA/QC checks

10.3.1. Summary

In order to evaluate data quality, QA/QC samples will be collected during the field remedial action. Table 8-1 lists the environmental and corresponding QC samples to be collected by analyses and matrix type.

10.3.2. Field duplicate samples

Collection of field duplicate samples provides for the evaluation of the laboratory's precision performance by comparing analytical results of two samples from the same location. Field duplicate samples are also collected to evaluate field sample collection precision procedures. Field duplicate samples are duplicate samples collected from one location and sent to the laboratory blind (with two different sample identifications).

One field duplicate sample will be collected for every 20 environmental samples (*i.e.*, minimum frequency of 5%) or one per matrix for less than 20 samples.

10.3.3. Matrix spikes and matrix spike duplicates

MS/MSD samples are duplicate samples that have spiking solutions added. MS/MSD samples are considered identical to the original sample and require that the sampled material be homogenized in the field and laboratory prior to analyses. Due to the potential loss of volatile compounds during homogenization, samples collected for VOC analyses will not be homogenized in the field. Since they will not be homogenized, field samplers must make every effort to collect representative samples of the location sampled for VOCs. The percent recovery of the spiked amount indicates the accuracy of the extraction as well as interferences caused by the matrix. Relative percent differences (RPDs) between spike sample recoveries will indicate the precision of the data. One MS/MSD sample set will be collected for every 20 environmental samples submitted to the laboratory or one per group of similar concentration and matrix (*i.e.*, minimum frequency of 5%).

10.3.4. Field rinsate blanks

These are samples of laboratory quality reagent water used to rinse the collection device and filters, coming into contact with the same surfaces as the sample. The quality control samples are then submitted with the field samples for analysis. This type of quality control sample helps to determine if the sample collection device is contributing any detectable material to the sample. The minimum number of this type of sampling quality control, if utilized, is dependent on operational considerations. If multiple samples are being collected with the same collection device, the field decontamination, at a minimum two of this type of quality control will be collected, one before sampling and one at the end of sampling.

10.3.5. Trip blanks

These are appropriate sample containers filled with laboratory quality reagent water that are transported to and from the Site and are shipped with the samples to the laboratory that will be analyzed for VOCs. These samples are intended to determine if there was any cross contamination that occurred during the shipping process. They will also validate that the sampling containers used were clean. Each sampling event that uses this type of quality control should have a minimum of one trip blank for each sample shipment.

10.4. Corrective action

Generally, the following corrective actions will be taken by the laboratory. When calibration, instrument performance, and blank criteria are not met, the cause of the problem will be located and corrected. The analytical system will then be recalibrated. Sample analysis will not begin until calibration, instrument performance, and blank criteria are met. The QAO will be notified of situations of repeated calibration, instrument performance, or blank criteria failure at the time of sample analysis. When matrix spike, reference standard, or duplicate analyses are out of control, samples analysis will cease. The problem will be investigated. Depending on the type of analysis and the results of overall QC program for the sample set, the data may be accepted, accepted with qualification, or determined unusable. If, through the application of the corrective action listed in Tables 10-1 through 10-4 the data is determined to be unusable, the QC analysis will be re-prepared and reanalyzed. If matrix interferences are suspected, samples will be subjected to one or more of the clean-up techniques specified in the analytical methods. If QC criteria are met upon reanalysis, only the new results are reported. If QC criteria are still not met upon reanalysis, one set of sample results will be reported and the second set of sample results will be maintained internally for support, and will be made available for data review upon request. The QAO will be notified of the corrective action situation at the time of sample analysis.

The laboratory will make every reasonable effort to correct QC excursions. The laboratory will document the presence of matrix interferences in the non-conformance summary. In this way, unnecessary resampling of difficult matrices may be avoided. However, if matrix interferences are not documented resampling may be required.

The corrective actions listed in Tables 10-1 through 10-4 are intended to supplement and/or clarify USEPA method requirements. The QAO will be contacted in the event that the information in the tables conflicts with that of the method. The corrective actions listed in Tables 10-1 through 10-4 will be followed by the laboratory.

10.5. Control

Control limits are either listed in the appropriate methods or are established by the laboratory for each matrix type for surrogate, LCS, LFB, LFM/LFMD, MS/MSD, and laboratory duplicate analyses. Control limits can be considered action limits. The laboratory established limits are defined as ±three standard deviations of the mean and correspond to 99.7% confidence limits of a normal distribution curve. For QC analyses that do not have method control limits, the laboratory will establish control limits for each analyte of concern using a minimum of twenty data points. During the validation, laboratory control limits will be reviewed against method limits, where applicable, to verify that laboratory control limits used will produce data that meets data quality objectives.

The control limits used to assess data for this program will be summarized by the laboratory in the analytical report.

10.6. Field sampling QA/QC

Field sampling crews will always be under direct supervision of a field sampling leader. Bound log books and appropriate data sheets will be used to document the collection of samples and data so that an individual sample or data set can be traced back to its point of origin, sampler, and type of sampling equipment. Field QA/QC samples include blind field duplicates, MS/MSD, field rinsate blanks and trip blank samples and will be collected by the sampling team. These samples will be sent to the laboratory for analysis in conjunction with the environmental samples. Field sampling precision will be evaluated through the RPD of the matrix spike and blind field duplicate sample analyses results. Control limits for the blind field duplicate precision have been established at ±50% for water samples. Decontamination of sampling equipment, if required, will be verified through the analysis of field rinsate blanks. The presence of matrix interferences will be evaluated by the analysis of spiked samples. The integrity of aqueous environmental submitted for VOC analysis will be evaluated by the analysis of trip blank samples which accompany each shipment of environmental samples to the laboratory. The trip blank results will be used to determine of contamination of the samples occurred during shipment and/or storage. Proper chain-of-custody protocols, as presented in Section 8 of this QAPP, will be followed.

10.7. Data assessment procedures

The procedures employed by the laboratory to assess the quality of data generated in the laboratory include, but are not limited to, the following:

- Determination of analytical precision per method
- Determination of analytical accuracy per method
- Determination of analytical completeness
- Determination of RLs.

Data quality reviews by analysts, supervisors. managers, laboratory directors, and QA personnel contribute to the total process.

Precision and accuracy may be assessed utilizing control charts. Control charts will consist of line graphs which provide a continuous graphic representation of the state of each analytical procedure. The standard deviation of the mean of the QC measurement is calculated and the upper and lower warning limits are set at plus or minus two standard deviation units. The upper and lower control limits are set at plus or minus three standard deviation units. Acceptable data are realized when results fall between the lower and upper warning limits. If the QC value falls between the control limit and the warning limit, the analysis should be scrutinized as possibly out of control.

In general, the accuracy of the methods will be determined by spiking the sample matrix with the analyte and by analyzing reference materials with known concentrations. The spiking levels will be selected to reflect the concentration range of interest. Percent recoveries of the spikes and reference materials will be calculated and compared to the established limits. The precision of the methods will be determined by the analysis of matrix spike and laboratory and field duplicate samples. The precision will be evaluated by calculating the RPD between the duplicates. RPD calculations will be compared to the established limits.

The definitions and equations used for the assessment of data quality are discussed below.

Accuracy - Is a measure of the nearness of an analytical result, or a set of results, to the true value. It is usually expressed in terms of error, bias, or percent recovery (%R).

Normally, the term accuracy is used synonymously with percent recovery. It describes either the recovery of a synthetic standard of known value, or the recovery of known amount of analyte (spike) added to a sample of known value. The %R or accuracy can be calculated by using:

standards %R = (observed value/true value) x 100

spikes: %R = ((conc. spike + sample conc.) - sample conc. x 100)/conc. spike

Precision - Refers to the agreement or reproducibility of a set of replicate results among themselves without assumption of any prior information as to the true result. It is usually expressed in terms of the percent difference (%D) or RPD. The %D is calculated by using:

%D = (larger SR - smaller SR x 100)/ smaller SR

where SR is the sample result. The RPD is calculated by using:

RPD = (|OSR - DSR| x 100)/ ((OSR + DSR)/2)

where OSR is the original sample result and DSR is the duplicate sample result.

Average - The average or arithmetic mean (X) of a set of n values (Xi) is calculated by summing the individual values and dividing by n:

$$X = (\sum Xi_{I=1 \text{ to } n})/n$$

Range - The range (R_i) is the difference between the highest and lowest value in a group. For n sets of duplicate values (X_2, X_1) the range (R_i) of the duplicates and the average range (R) of the n sets are calculated by the following:

$$R_i = X_2 - X_1$$

$$R = \sum Ri_{i=1 \text{ to } n}/n$$

Standard Deviation and Variation - The standard deviation (S) of a sample of n results is the most widely used measure to describe the variability of a data set. It is calculated by using the following equation:

$$S = \sqrt{\frac{\sum (Xi - X)^2_{i-1 \text{ to } n}}{n}}$$

where X is the average of the n results and Xi is the value of result. Normally, X ± S will include 68% and X ± 2S includes about 95% of normally distributed data.

The variance is equal to S^2. The percent relative standard deviation (%RSD) or coefficient of variation (CV) is the standard deviation divided by the mean and multiplied by 100 as follows:

$$CV = 100S/X$$

The Laboratory QC Coordinator, with individual laboratory group leaders, will identify any data that should be rated as "unacceptable", based on the assessment of the QA/QC criteria and will document these issues in the non-conformance summary. Data assessment will be evaluated during data validation and discussed in the data validation report(s).

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Holding times	Samples must be extracted and analyzed within holding time.	VOCs: Analyze within 14 days from collection.	If holding times are exceeded for initial or any reanalyses required due to QC excursions, notify QAO* immediately since resampling may be required. Document corrective action in the non-conformance summary.
MS Tuning	Once every 12 hours prior to initial calibration and calibration verifications.	1. BFB key ions and abundance criteria listed in the method must be met for all 9 ions and analyses must be performed within 12 hours of injection of the BFB. 2. Part of the BFB peak will not be background subtracted to meet tune criteria. 3. Documentation of all BFB analyses and evaluation must be included in the data packages.	1. Tune the mass spectrometer. 2. Document corrective action in the non-conformance summary - **samples cannot be analyzed until control limit criteria have been met.**

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Initial Calibration	Prior to sample analysis and when calibration verifications criteria are not met. Initial calibration will contain all target analytes in each standard.	1. Five concentrations bracketing expected concentration range for all compounds of interest; one std must be near the RL. 2. CCC compounds ≤30% RSD, remaining compounds ≤50% RSD. 3. SPCC RF as listed in method, non-SPCC ≥ 0.050 RF except for ketones and 2-chloroethyl vinyl ether with RF ≥ 0.010. 4. For compound with %RSD >15, quantitation must be performed using a separate calibration curve and the COD must be ≥ 0.990.	1. Identify and correct problem. 2. If criteria are still not met, recalibrate. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until calibration control limit criteria are met.**
Calibration Verification	Every 12 hours, following BFB. The calibration verification will contain all target analytes in each standard at a concentration that is representative of the midpoint of the initial calibration.	1. Within method specified criteria, and percent drift or percent difference (%D)≤ 20 for CCC compounds, ≤ 50% D for remaining compounds, SPCC RF same as listed in initial calibration. 2. The internal standards areas and retention times must meet the method criteria.	1. Reanalyze. 2. If criteria are still not met, identify and correct problem, recalibrate and notify QAO*. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until calibration control limit criteria are met.**

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Preparation Blank Analysis	Every 12 hours, following calibration verification	Common laboratory contaminants (methylene chloride, acetone) less than 3 X RL; anything else less than RL. RLs will be provided along with the preparation blank results.	1. Reanalyze blank. 2. If limits are still exceeded, contact QAO*, clean instrument, recalibrate analytical system, and reanalyze all samples if detected for same compounds as in blank. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until blank criteria have been met.**
Field / Equipment Blank Analysis	Every 20 samples.	Common laboratory contaminants less than 3 X RL; anything else less than RL.	1. Investigate problem, contact QAO*. 2. Write an explanation in the non-conformance summary.
Trip Blank	1 per cooler containing VOC samples.	Common laboratory contaminants less than 3 X RL; anything else less than RL.	1. Investigate problem, contact QAO*. 2. Write an explanation in the non-conformance summary.
Laboratory Control Sample Analysis (Blank Spike)	Each analytical batch (every 12 hours). Prepared independently from calibration standards. Spike must contain all target analytes and should be at a concentration which is in the lower half or midpoint of the calibration curve.	Recovery within laboratory control limits. For compounds without established laboratory control limits, 50 to 150% recovery will be used.	1. If recovery failures are above control limits and these compounds are not detected in the associated samples, contact QAO*. 2. If recovery failures are below control limits, reanalyze LCS and examine results of other QC analyses. 3. If recovery is still outside limits, and other QC criteria are met, contact QAO*. 4. If other QC criteria have not been met, stop analysis, locate and correct problem, recalibrate instrument and reanalyze samples since last satisfactory LCS. 5. Document corrective action in the non-conformance summary.

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Internal Standards	All samples and blanks (including MS/MSD)	1. Response -50% - +100% of internal standards from continuing calibration of the day. 2. RT must be ± 30 sec. from associated calibration verification standard of that sequence.	1. Reanalyze. 2. If still outside of the limits, report both analyses, and contact the QAO*. 3. Document corrective action in the non-conformance summary.
Surrogate Spike	All samples and blanks (including MS/MSD)	Recovery within laboratory control limits.	1. Reanalyze any environmental or QC sample with surrogates that exceed control limits. 2. If still outside of the limits, report both analyses and contact the QAO*. 3. Document corrective action in the non-conformance summary.

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Matrix Spike/ Matrix Spike Dup. (MS/MSD) Analysis	1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20, whichever is greater.	Recovery and RPD within laboratory control limits.	1. Reanalyze if <10%. 2. If reanalysis is still <10%, report both analyses and document in the non-conformance summary. 2. If >10% and LCS criteria are met, document in non-conformance summary; no additional corrective action required. 3. If LCS criteria are exceeded also, examine other QC data for source of problem; *i.e.*, surrogate recoveries for extraction efficiency and calibration data for instrument performance issues, and contact QAO*. Re-extract or reanalyze samples and associated MS/MSD and LCSs as required.
Field Dup. Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters and 100% RPD for soil.	If these criteria are not met, sample results will be evaluated on a case by case basis.
Tentatively Identified Compounds	If required, perform for each sample and blank analysis. Non-target compounds will be reported using a Mass Spectral Library search.	Not applicable	Not applicable

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Dilutions	1. When target analyte concentration exceeds upper limit of calibration curve. 2. When matrix interference is demonstrated by the lab and documented in the non-conformance summary (highly viscous samples or a large number of nontarget peaks on the chromatogram). The QAO* will be contacted. 3. **A reagent blank will be analyzed if an analyte saturates the detector or if highly concentrated analytes are detected.** 4. Laboratory will note in the data deliverables which analytical runs were reported.	1. The reagent blank will meet the method blank criteria.	1. Reanalyze reagent blank until method blank criteria are met. 2. **Contact the QAO* in the case that an analyte saturates the detector or if highly concentrated analytes are detected to discuss the corrective action to be taken.**
Laboratory control limits	1. Generated with results for an analyte from a minimum of 20 sample analyses. The average of the sample results and the standard deviation are calculated. The internal warning limits are established at 2 times the standard deviation and the control limits are established at 3 times the standard deviation. The control limits are updated annually.	Not applicable	Not applicable

Table 10-1. *Volatile Organic Compounds using USEPA Method 8260B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Note: QAO* indicates that communications with the QAO will be documented and included in the data packages.			

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Holding times	Samples must be analyzed within holding time.	VOCs: Analyze within 14 days from collection.	If holding times are exceeded for initial or any reanalyses required due to QC excursions, notify QAO* immediately since resampling be required. Document corrective action in the non-conformance summary.
MS Tuning	Once every 12 hours prior to initial calibration and calibration verifications.	1. BFB key ions and abundance criteria listed in the method must be met for all 9 ions and analyses must be performed within 12 hours of injection of the BFB. 2. Part of the BFB peak will not be background subtracted to meet tune criteria. 3. Documentation of all BFB analyses and evaluation must be included in the data packages.	1. Tune the mass spectrometer. 2. Document corrective action in the non-conformance summary - **samples cannot be analyzed until control limit criteria have been met.**

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Initial Calibration	Prior to sample analysis and when continuing calibration criteria are not met. Initial calibration will contain all target analytes in each standard.	1. Purge medium calibration solution standard (10-20 µg/L). 2. Check chromatogram for symmetrical peaks with minimum tailing. 3. Each GC peak must be identified in the appropriate retention time window. 4. Purge remaining 4 standards, with concentrations bracketing expected concentration range for all compounds of interest. 5. Response factor (RF) must be > 0.1 for target compounds and surrogates. The RSD of the mean RF must be ≤20% or the linear or second order regression curve COD must be ≥ 0.990.	1. Identify and correct problem. 2. If criteria are still not met, recalibrate. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until calibration control limit criteria are met.**

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Continuing Calibration	Every 12 hours, following BFB. The calibration verification will contain all target analytes in each standard at a concentration that is representative of the low end or midpoint of the initial calibration.	1. Within element #2 and #3 of the initial calibration criteria. 2. Areas of the internal standard for the target compounds and surrogates must not decrease by >30% when compared to the area of the most recent continuing calibration, or must not decrease by >50% for areas from the initial calibration. 3. The RF must be within 30% difference of the average RF from the initial calibration or ±30% of the true value if linear or second order regression is used.	1. Reanalyze. 2. If criteria are still not met, identify and correct problem, recalibrate and notify QAO*. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until calibration control limit criteria are met.**
Lab Reagent Blank (LRB)	With each analytical batch.	Common laboratory contaminants (methylene chloride, acetone) less than 3 X RL; anything else less than RL. RLs will be provided along with the preparation blank results.	1. Reanalyze blank. 2. If limits are still exceeded, contact QAO*, clean instrument, recalibrate analytical system, and reanalyze all samples if detected for same compounds as in blank. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until blank criteria have been met.**

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Field Blank Analysis	Every 20 samples, if required.	Common laboratory contaminants less than 3 X RL; anything else less than RL.	1. Investigate problem, contact QAO*. 2. Analyze LFB to locate source of contamination. 3. Write an explanation in the non-conformance summary.
Trip Blank	1 per cooler containing VOC samples.	Common laboratory contaminants less than 3 X RL; anything else less than RL.	1. Investigate problem, contact QAO*. 2. Write an explanation in the non-conformance summary.
Laboratory Fortified Blank (LFB)	Each analytical batch (20 samples). Prepared independently from calibration standards. Spike must contain all target analytes, at a concentration of 0.2-5µg/L. (See Section 9.3 of the USEPA method.)	Recovery within 70-130%.	1. If recovery failures are above control limits and these compounds are not detected in the associated samples, contact QAO*. 2. If recovery failures are below control limits, reanalyze LFB. 3. If recovery is still outside limits, contact QAO, stop analysis, locate and correct problem, recalibrate instrument and reanalyze samples since last satisfactory LFB. 4. Document corrective action in the non-conformance summary.
Internal Standards	All samples and blanks (including MS/MSD)	1. Response -50% - +100% of internal standards from continuing calibration of the day. 2. RT must be ± 30 sec. from associated calibration verification standard of that sequence.	1. Reanalyze. 2. If still outside of the limits, report both analyses, and contact the QAO*. 3. Analyze LFM/LFM duplicate. 4. Document corrective action in the non-conformance summary.

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Surrogate Spike	All samples and blanks (including MS/MSD)	Recovery within 70-130%.	1. Reanalyze any environmental or QC sample with surrogates that exceed control limits. 2. If still outside of the limits, report both analyses and contact the QAO*. 3. Analyze LFM/LFM duplicate. 4. Document corrective action in the non-conformance summary.
Laboratory Fortified Sample Matrix (LFM)/ LFM Duplicate Analysis	If internal standard or surrogate recoveries fail criteria.	Recovery and RPD within laboratory control limits. Spike must contain target analytes.	1. Reanalyze if <10%. 2. If reanalysis is still <10%, report both analyses and document in the non-conformance summary. 2. If >10%, document in non-conformance summary, flag sample results; no additional corrective action required.
Field Dup. Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters and 100% RPD for soil.	If these criteria are not met, sample results will be evaluated on a case by case basis.
Target Analyte Identification	The retention time must be within 3 standard deviations of the mean retention time from the continuing calibration.	1. See Section 11.6 of the USEPA method.	

Table 10-2. *Volatile Organic Compounds using USEPA Method 524.2 Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Dilutions	1. When target analyte concentration exceeds upper limit of calibration curve. 2. When matrix interference is demonstrated by the lab and documented in the non-conformance summary (highly viscous samples or a large number of nontarget peaks on the chromatogram). The QAO* will be contacted. 3. **A reagent blank will be analyzed if an analyte saturates the detector or if highly concentrated analytes are detected.** 4. Laboratory will note in the data deliverables which analytical runs were reported.	The reagent blank will meet the method blank criteria.	1. Reanalyze reagent blank until method blank criteria are met. 2. **Contact the QAO* in the case that an analyte saturates the detector or if highly concentrated analytes are detected to discuss the corrective action to be taken.**
Laboratory control limits	1. Generated with results for an analyte from a minimum of 20 sample analyses. The average of the sample results and the standard deviation are calculated. The internal warning limits are established at 2 times the standard deviation and the control limits are established at 3 times the standard deviation. The control limits are updated annually.	Not applicable	Not applicable

Note:
QAO* indicates that communications with the QAO will be documented and included in the data packages.

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Holding Times	Samples must be digested and analyzed within holding time.	Metals: Analyze 6 months from collection. Mercury: Analyze 28 days from collection. Cyanide: Analyze 14 days from collection.	If holding times are exceeded for initial or any reanalyses required due to QC excursions, notify the QAO* immediately since resampling may be required.
Initial Calibration and Calibration Verification (ICV, CCV)	1. Four point calibration for ICP. 2. Six point calibration for Hg. 3. Five point calibration for remaining methods. 4. Calibrate according to method and each time instrument is set up; analyze HSA (highest standard) ICV, ICB, following initial calibration. 5. Verify with CCV, CCB every 10 samples and at the end of each run. 6. Standard at or below the PQL should be analyzed after the initial calibration for ICP. 7. For remaining methods, the lowest standard is at or below the PQL.	1. 90% to 110% of expected value for ICP AA and spectrophotometer. 2. 80% to 120% of expected true value for mercury. 3. Highest std. mix ± 5% of true value for ICP. 4. Correlation coefficient for first or second order curve must be ≥0.995.	1. Reanalyze. 2. If criteria are still not met, identify and correct problem, recalibrate. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until calibration control limit criteria have been met.**

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Calibration Blank	At beginning and end of run and after every 10 samples.	Less than PQL.	1. Identify and correct problem. 2. If criteria are still not met, recalibrate. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until blank control limit criteria have been met.**
Preparation Blank Analysis	1 per batch of samples digested, or 1 in 20, whichever is greater.	Less than PQL.	1. Reanalyze blank. 2. If limits are still exceeded, clean instrument and recalibrate analytical system and reprep and reanalyze affected samples if detected. 3. Document corrective action in the non-conformance summary - **samples cannot be analyzed until blank criteria are met.**
Field/Equipment Blank Analysis	Every 20 samples	Less than PQL	1. Investigate problem, contact QAO*. 2. Document in the corrective action in the non-conformance summary.

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Laboratory Control Sample Analysis	1. Every 20 samples or each digestion batch. 2. Prepared independently from calibration standards.	1. Recovery within laboratory control limits. 2. 80-120% for waters. 3. Certified limits for soil.	1. Reanalyze LCS and examine results of other QC analyses. 2. If recovery is still outside limits, and other QC criteria are met, contact QAO*. 3. If other QC criteria have not been met, stop analysis, locate and correct problem, recalibrate instrument and reanalyze samples since last satisfactory LCS. 4. Document corrective action in the non-conformance summary.
Post Digestion Spike Analysis	Every 20 samples.	Recovery within 75-125% of the true value.	1. Dilute sample and reanalyze. 2. If recovery is still outside limits, contact QAO*. 3. Document corrective action in the non-conformance summary.
Serial Dilution Analysis	Required when analyte concentration is >10 times the IDL after dilution for ICP.	An analysis of a 1:5 dilution of the sample should provide a result with 90% to 110% of the original determination (for concentrations 10x the IDL).	1. Reanalyze. 2. Document corrective action in the non-conformance summary.

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Interference Check Sample Analysis	Beginning and end of each analytical run or twice during every 8 hours, whichever is more frequent for ICP.	Percent recovery of all elements should be between 80% and 120%.	1. Reanalyze. 2. If limits are still exceeded, adjust interference corrections for instrument, contact QAO*, **samples cannot be analyzed until ICSA/ICSAB control limit criteria have been met..** 3. Restart analytical run and reanalyze samples analyzed since last satisfactory ICS. 4. Document corrective action in the non-conformance summary.
Matrix Spike Analysis	1. 1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20, whichever is greater. 2. Spike must contain all analytes	1. Recovery within in-house control limits (does not apply if sample conc > 4 X spike conc). 2. 75 - 125% for soils 3. 80 - 120% for waters	1. Analyze post digestion spike. 2. Document corrective action in the non-conformance summary.
Laboratory Duplicate Analysis	1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20, whichever is greater.	20% RPD less than in-house limits for conc > 10 times the IDL.	1. Investigate problem and reanalyze. 2. Document corrective action in the non-conformance summary.
Field Dup. Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters and 100% RPD for soil.	If these criteria are not met, sample results will be evaluated on a case by case basis.

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Furnace Analysis	Every sample must be injected in duplicate and spiked; method of standard additions is required when the sample absorbance or concentration is ≥ 50% of the spike concentration and the recovery is not within control limits.	%Recovery 85% to 115%, Relative Standard Deviation <20%. MSA correlation coefficient > 0.995.	1. Dilute and reanalyze if <40% recovery, reanalyze 40%-60% recovery and no MSA. 2. If limits are still exceeded, qualify data. 3. Document corrective action in the non-conformance summary.
Dilutions	1. Dilute and reanalyze samples with concentrations that are greater than the linear range of the instrument. 2. The laboratory will note in the data package which analytical runs were used to report the sample results.	Not applicable	Repeat analysis using correct application of dilutions.
Percent solids	For soil samples, the percent solids will be determined and sample results will be corrected for percent solids.	Not applicable	Not applicable

Table 10-3. *Metals USEPA Method 6010B Quality Control Requirements and Corrective Actions*

Audit	Frequency	Control Limits	Corrective Action
Laboratory control limits	1. Generated with results for an analyte from a minimum of 20 sample analyses. The average of the sample results and the standard deviation are calculated. The internal warning limits are established at 2 times the standard deviation and the control limits are established at 3 times the standard deviation. The control limits are updated annually.	Not applicable	Not applicable
Deliverables	CLP-like deliverables must be provided to document each audit item for easy reference and inspection.	Not applicable	Provide missing or additional deliverables for validation purposes.
Note: QAO* indicates that communications with the QAO will be documented and included in the data package.			

Table 10-4. *Inorganic Analyses Quality Control Requirements and Corrective Actions (Fluoride USEPA Method 340.2, Total Organic Carbon USEPA Method 415.1, Total Dissolved Solids USEPA Method 160.1, Total Suspended Solids USEPA Method 160.2)*

Audit	Frequency	Control Limits	Corrective Action
Holding Times	Samples must be digested and analyzed within holding time.	Fluoride - 28 days from collection TO - 28 days from collection TDS, TSS - 7 days from collection hardness - 6 months from collection	If holding times are exceeded for initial or any reanalyses required due to QC excursions, notify the QAO* immediately since resampling may be required.
Calibration Verification (ICV, CCV)	Minimum of five point calibration every 3 months. ICV each time instrument is set up; verify with CCV at frequency of 10%. Analyze reagent blank every batch.	90% to 110% of expected value. If used, correlation coefficient for first or second order curve must be ≥0.995.	1. Reanalyze. 2. If criteria are still not met, identify and correct problem, recalibrate. 3. Document corrective action - samples cannot be analyzed until calibration control limit criteria have been met.

Table 10-4. *Inorganic Analyses Quality Control Requirements and Corrective Actions (Fluoride USEPA Method 340.2, Total Organic Carbon USEPA Method 415.1, Total Dissolved Solids USEPA Method 160.1, Total Suspended Solids USEPA Method 160.2)*

Audit	Frequency	Control Limits	Corrective Action
Preparation Blank Analysis	1 per batch of samples digested, or 1 in 20, whichever is greater.	Less than PQL.	1. Reanalyze blank. 2. If limits are still exceeded, clean instrument and recalibrate analytical system and reprep and reanalyze affected samples if detected. 3. Document corrective action - samples cannot be analyzed until blank criteria are met.
Laboratory Control Sample Analysis (where applicable)	Every 20 samples or each digestion batch. Prepared independently from calibration standards.	Recovery within laboratory control limits.	1. Reanalyze LCS and examine results of other QC analyses. 2. If recovery is still outside limits, and other QC criteria are met, contact QAO*. 3. If other QC criteria have not been met, stop analysis, locate and correct problem, recalibrate instrument and reanalyze samples since last satisfactory LCS. 4. Document corrective action.
Matrix Spike Analysis (where applicable)	1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20, whichever is greater.	Recovery within in-house control limits (does not apply if sample conc > 4 X spike conc).	1. Reanalyze. 2. Document corrective action.
Laboratory Duplicate Analysis	1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20, whichever is greater.	RPD less than in-house limits for concentrations > 5X PQL. Absolute difference less than PQL otherwise.	1. Investigate problem and reanalyze. 2. Document corrective action.

Table 10-4. *Inorganic Analyses Quality Control Requirements and Corrective Actions (Fluoride USEPA Method 340.2, Total Organic Carbon USEPA Method 415.1, Total Dissolved Solids USEPA Method 160.1, Total Suspended Solids USEPA Method 160.2)*

Audit	Frequency	Control Limits	Corrective Action
Field Dup. Analysis	1 per matrix and analytical batch and every 20 samples of similar matrix	50% RPD for waters and 100% RPD for soil.	No corrective action required of the laboratory since the laboratory will not know the identity of the field duplicate samples. If these criteria are not met, sample results will be evaluated on a case by case basis.
Note: QAO* indicates that communications with the QAO will be documented and included in the data package.			

11. Instrument/equipment testing and maintenance

Each major piece of analytical laboratory instrumentation that will be used on this project has been documented and is on file with the laboratory. An equipment form will be prepared for each new purchase and old forms will be removed from the instrument area and filed when an instrument is replaced.

The laboratory will be required to maintain an equipment form detailing both preventative maintenance activities and the required QA testing and monitoring. In the event the instrument does not perform within the limits specified on the monitoring form, the Laboratory Manager will be notified and a decision will be made as to what corrective action is necessary. The corrective action procedure shall be documented in the instrument log. If repair is necessary, an "out-of-order" sign will be placed on the instrument until repairs are completed. Repairs made to the instrument will be documented in the instrument log book. Required QA/QC testing and monitoring will be completed prior to the resumption of sample analysis.

Preventative maintenance procedures will be carried out on field equipment by O'Brien & Gere personnel in accordance with the procedures outlined by the manufacturer's equipment manuals. Maintenance activities involving field equipment will be recorded in the field notebook.

Routine maintenance is performed to keep laboratory instruments running under optimum conditions and to reduce instrument malfunction. Specific preventative maintenance programs outlining required maintenance procedures and their application frequencies are incorporated in laboratory SOPs for each methodology.

Minimally, field and laboratory instruments will undergo maintenance on an annual basis and when calibration, blank, or QC analyses indicate that maintenance is necessary to correct or improve system performance. Maintenance, whether performed by laboratory personnel or manufacturer, is documented as an entry in the appropriate log. Log entries include the reason for maintenance, maintenance performed, date, and initials of person in charge during maintenance.

The operating temperatures for refrigerators, coolers, ovens, water baths will be monitored by the laboratory daily. The analyst will record the following information in a bound log book: equipment ID, temperature reading, data and time of reading, and analysis initials.

12. Calibration and frequency

12.1. Field equipment calibration

Field equipment used to collect specific conductance, pH, temperature, flow, and turbidity data will be calibrated in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Equipment to be used for the field sampling will be examined to certify that it is in good operating condition. This includes checking the manufacturing's operating manual and the instructions for each instrument to check that the maintenance requirements are being observed.

Calibration of field instruments is governed by the specific Standard Operating Procedure for the applicable field analysis method. The calibration will be performed at the intervals specified by the manufacturers. In the event that an internally calibrated field instrument fails to meet calibration procedures, it will be returned to the manufacturer for service.

12.2. Laboratory equipment calibration

12.2.1. Responsibility

Proper calibration of laboratory analytical instrumentation is essential for the generation of reliable data which meets the project's DQOs. Analytical instrument calibration is monitored through the use of control limits which are established for individual analytical methods. Calibration procedures to be followed are specified, in detail, in the analytical methods. These procedures specify the type of calibration,

calibration materials to be used, range of calibration, and frequency of calibration.

The laboratory will be responsible for proper calibration and maintenance of laboratory analytical equipment. Calibration procedures are presented in the analytical methods and the laboratory QA Manual. The following subsections briefly discuss some of the calibration procedures outlined in the analytical methods and the laboratory QA Manual.

12.2.2. Organics-gas chromatography/mass spectrometry (GC/MS)
Before the GC/MS is calibrated for volatile and semivolatile analysis, the mass calibration and resolutions of the instruments are verified by a 50 nanogram (ng) injection of 4-bromofluorobenzene (BFB) for VOCs or by a 50 ng injection of decafluorotriphenylphosphine (DFTPP) for SVOCs. The tune must meet the ion abundance criteria specified in the analytical method. The system must be verified every 12 hours of analysis and when the instrument performance check solution fails to meet criteria. After re-tuning, the performance check solution is reanalyzed. Samples are not analyzed until tuning criteria are met.

For volatile and semivolatile analysis, an initial five-point calibration is performed for the target compounds prior to start-up and whenever system specifications change or if the continuing calibration acceptance criteria have not been met. One of the calibration standards should be at a concentration near the method detection limit. The relative response factors (RRFs) and percent relative standard deviation (% RSD) of specific compounds must meet established criteria as specified in the method. If these parameters fail to meet criteria, corrective actions must be implemented and the initial calibration must be repeated. A midpoint continuing calibration standard containing the target compounds is analyzed at the beginning of every 12 hour period following the GC/MS tune. This standard must meet specific QC limits listed in the method to verify that the initial five-point calibration is still valid.

12.2.3. Metals and inorganics
Instrument calibration for metal analyses is performed daily. A two point calibration for inductively coupled plasma (ICP) analyses is performed. Five point calibrations are performed for spectrophotometers and colorimeters. The calibration curves must have correlation coefficients greater than or equal to 0.995. Calibration verification is monitored by

analyzing a calibration verification standard and a calibration blank following calibration, every ten samples, and at the end of the analytical sequence. The calibration verification standard recovery must be withing 90% to 110%, or the instrument must be resloped and, if necessary, recalibrated. The calibration blank must not contain target compounds at concentrations greater than the PQL or corrective actions are implemented. To verify interelement and background corrective factors for ICP analysis. interference check samples (ICSA and ICSAB) must be analyzed at the beginning and end of the analysis sequence or a minimum of twice per eight hours. The percent recoveries for ICS solutions must be withing 80% to 120% or corrective actions must be implemented. In addition, for ICP analyses, a serial dilution analysis must be performed per sample matrix. If the analyte concentration is greater than fifty times the method detection limit (MDL) in the original sample, a serial dilution (five fold dilution) must agree within ten percent of the original determination. Detection limits, interelement corrective factors, and linear ranges must be established at the frequency specified in the method.

12.3. Standards and solutions

The use of standard materials of a known purity and quality is necessary for the generation of reproducible data. The laboratory will monitor the use of laboratory materials including solutions, standards, and reagents. Standards and standard solutions are obtained from the USEPA or USEPA-certified commercial vendors. Standard reference materials and performance evaluation materials are obtained from the NIST or USEPA-certified commercial vendors.

Standards and standard solutions are verified prior to use. This verification may be in the form of a certification from the supplier. Standards may also be verified by comparison to a standard curve or another standard from a separate source. Standards are routinely checked for signs of deterioration, including unusual volume changes, discoloration, formation of precipitates, or changes in analyte response. Standards are replaced when expiration dates as provided by the manufacturer or if method holding times, whichever is less, have been exceeded.

Solvent materials are also verified prior to use. Each new lot of solvent is analyzed to verify the absence of interfering constituents. Reagent and method blanks are routinely analyzed to evaluate possible laboratory-based contamination of samples.

12.4. Records

A records book will be kept for standards and will include the following information:

- Material name
- Control or lot number
- Purity and/or concentration
- Supplier/manufacturer
- Receipt/preparation date
- Recipient's/preparer's name
- Expiration date.

These records will be checked periodically as part of the laboratory internal laboratory controls review.

12.5. Calibration records

Calibration information records will be available for each instrument that requires calibration. The calibration information records will account for activities associated with QA monitoring and instrument repairs. These records will be checked during periodic equipment review and internal and external QA/QC audits.

12.6. Inspection requirements for supplies

The use of standard materials and of solvent of a known purity and quality is necessary for the generation of reproducible data.

The sample containers used for this project will be supplied by the laboratory. The containers will be pre-cleaned sample containers that will be purchased from a USEPA-certified manufacturer (I-Chem 200 or equivalent container).

12.7. Data acquisition requirements

Non-direct measurement data are not currently anticipated to be utilized for sampling activities at the site.

12.8. Data management

Data will be generated in the laboratory for critical methods and in the field for non-critical methods. The generated data will be entered into the laboratory database management system. Records described in Sections 6, 8.2, and 13.4 will be incorporated into the final project files for the samples. The data review process described in Section 14 will be performed by the laboratory.

13. Performance and system audits

13.1. Performance and system audits

13.1.1. Program elements

At the discretion of the Project Manager, field and laboratory performance audits consisting of on-site performance evaluations will be performed once during the field program and during the laboratory analysis program. The audits will be performed by O'Brien & Gere's QAO or her designee. These audits will evaluate the adherence of the field and laboratory programs to the QA program outlined in this QAPP. The protocols used to conduct the audits may be found in the following sections. Acceptance criteria used in determining the need for corrective action will be those criteria defined in this QAPP. Where acceptance criteria are not defined for laboratory procedures and analytical methods, the laboratory's standard operating procedure and QA Manual will be consulted. The results of the field and laboratory audits will be documented and submitted to the Project Manager. These reports and any corrective actions which were implemented as a result of the audits will be included in the project report.

13.1.2. Laboratory audit protocol

The laboratory audit will note factors which may affect the quality of the analytical results. Minimum QA/QC criteria specified in this QAPP and the analytical methods must be adhered to. The areas of concern of the laboratory audit will include:

- Implementation of a scientifically sound QA/QC program addressing precision, accuracy, reproducibility, comparability, completeness, and blank contamination

- Sufficient documentation and record keeping for technical personnel external to the laboratory to recreate each analytical event

- Compliance with the project requirements for laboratory analysis.

The specific parameters to be evaluated include:

- Data comparability
- Calibration and quantitation
- QC execution
- Out-of-control events
- Standard operating procedures
- Sample management
- Record keeping
- Instrument calibration records
- Other analytical records
- QC records
- Corrective action reports
- Maintenance logs
- Data review
- Limits of detection
- QC limits
- Analytical methods.

13.1.3. Field audit protocol

The purpose of a field audit is to identify whether the systems and procedures described in the QAPP are operational in the field and contributing to the production of accurate and defensible analytical results. An on-site evaluation will be preformed by the QAO or her designee. The areas of concern in a field audit include:

- Sampling procedures
- Decontamination of sampling equipment, if applicable
- Chain-of-custody procedures
- Standard operating procedures
- Proper documentation in field notebooks.

13.2. System audits

Routine laboratory and field performance will be monitored through the analysis of equipment and laboratory blanks, spiked samples, laboratory control samples, laboratory and field duplicates, and performance evaluation samples. The Laboratory QC Coordinator, in conjunction with the QAO and the Project Manager, will formulate corrective actions in the event that QC limits specified in this document are exceeded. The results of the system audits will be documented in the project report.

13.3. Corrective actions

Corrective action procedures will be implemented based on unacceptable audit results or upon detection of data unacceptableness during validation. Two types of audits will be performed during this remedial action. The data generation process will be audited by assessing adherence to control limits and by performing an on-site laboratory audit, if requested by the Project Manager. The field program will be audited by assessing adherence to the procedures outlined in this document by the analysis of field QC samples and by performing an on-site field audit, if requested by the Project Manager. If required, corrective action procedures will be developed on a case-by-case basis. The enacted corrective actions will be documented in the appropriate notebook, log, or case file. File and laboratory personnel are encouraged to discuss specific issues and proposed corrective actions with the QAO.

The following corrective actions will be taken by the laboratory. When calibration, instrument performance, and blank criteria are not met, the cause of the problem will be located and corrected. The analytical system will then be recalibrated. Sample analysis will not begin until calibration, instrument performance, and blank criteria are met. The QAO will be notified of situations of repeated calibration, instrument performance, or blank criteria failure at the time of sample analysis. When matrix spike, reference standard, or duplicate analyses are out of control, samples analysis will cease. The problem will be investigated. Depending on the type of analysis and the results of overall QC program for the sample set, the data may be accepted, accepted with qualification, or determined unusable. If, through the application of the corrective action listed in Tables 10-1 through 10-4 the data are determined to be unusable, the QC analysis will be re-prepared and reanalyzed. If matrix interferences are suspected, samples will be subjected to one or more of the clean-up techniques specified in the analytical methods. If QC criteria are met upon reanalysis, only the new results are reported. If QC criteria are still not met upon reanalysis, both sets of sample results will be reported and the QAO will be notified of the situation at the time of sample analysis.

The laboratory will make every reasonable effort to correct QC excursions. The laboratory will document the presence of matrix interferences in the non-conformance summary. In this way, unnecessary resampling of difficult matrices may be avoided. However, if matrix interferences are not documented resampling may be required.

The corrective actions listed in Tables 10-1 through 10-4 will be followed by the laboratory.

If problems arise with procedures or guidelines set forth herein, the client, the QAO, and the Project Manager, in conjunction with the appropriate agencies, will formulate an appropriate corrective action.

13.4. QA reports to management

The deliverables associated with sampling activities at the site will contain sections in which data quality information collected during the remedial action is summarized. These reports will be prepared under the direction of the Project Manager and will include the QAO's report on the accuracy, precision, and completeness of the data and the results of the performance and system audits, if required.

14. Data review, validation and verification

14.1. Program goals

For data to be scientifically valid, legally defensible, and comparable, valid procedures must be used to prepare this data. The data packages provided by the laboratory will contain Contract Laboratory Program (CLP)-like deliverables, which are described in Appendix QAPP-A. In addition, if during the course of the data validation process additional information is need to complete the data review process, the laboratory may be requested to provide additional data or information.

14.2. Data production, handling and reporting

14.2.1. Program elements

Specific laboratory procedures and instrumentation can be found in the QA Manual and/or standard operating procedures (SOPs) from the laboratory. The data production and reporting procedures described below will be employed at the laboratory.

14.2.2. Data reduction

Data reduction consists of manual and computer data reduction procedures and calculations. Computer data reduction procedures and calculations will be checked manually by the laboratory to verify that compound identification and quantitation adhere to method requirements. The laboratory will be responsible for maintaining a listing of computer-based data reduction programs and SOPs for data reduction. Sample preparation or extraction logs will be used to document sample preparation information (for example, preparation weights, volumes, reagents). Instrument injection logs or bench sheets will also be maintained for each instrument.

Qualitative identification and quantitation of organic analytes will be performed by experienced analysts in accordance with analytical method requirements.

14.2.3. Laboratory data review

Analytical results are entered into the laboratory computer system by the analyst, independently reviewed by another analyst or supervisor experienced in the method, and approved by the Laboratory Manager. The following are requirements that are generally examined as part of this review:

- Initial calibration criteria were met. Standards in the calibration curve covered the expected concentration ranges of the samples including the RL.

- Initial and continuing calibrations met the acceptance criteria defined in the method standard procedure.

- Sample results fell within the range of the standard curve.

- For GC/MS methods requiring internal standards, retention times and area responses were evaluated against limits established by the daily calibration.

- Method blanks were processed with each analytical batch and no detectable levels of contamination were identified.

- MS/MSDs were performed at the required frequency and recoveries were within acceptable control limits.

- Duplicate analyses were performed at the required frequency and results were within the control limits.

- LCS analyses were performed with each analytical batch and the results obtained were within control limits.

- For organic compound analyses, surrogate spike recoveries were within control limits.

- Compounds identified by GC/MS have been manually rechecked by comparison with the data system library for both target compounds and tentatively identified compounds if required. Retention times and ratios of fragmentation were verified.

- Calculations have been accurately performed.
- Reporting units are correct.
- Data for the analysis provide a complete audit trail.
- Reported detection limits comply with data quality indicator requirements.

The analyst's supervisor will check a minimum of 10% of the data back to raw data in the secondary review. When required analyses on the samples in a project are complete, entered, and reviewed, a report will be generated. The report will be forwarded to the assigned Laboratory Project Supervisor or designee for review. The report will then be reviewed for the following items (at a minimum):

- QC data will be reviewed to identify whether or not internal specification and contract requirements have been met.
- Non-conformance reports, if any, will be reviewed for completion of corrective actions and their impact of results. Tables 10-1 to 10-4 in this QAPP will be referenced in the laboratory review process. Non-compliance and corrective action procedures will be documented in the non-conformance summary in the data package.

The report requires the signature of the Laboratory Project Supervisor or designee. Electronic data are copied onto computer tape, inventoried, and stored off-site in a secure facility, or within locked cabinets on site. This data archive system is maintained for a minimum of five years.

Following final review, two copies of the report will be transmitted to O'Brien & Gere.

Analytical data packages which are fully validatable, and document sample preparation, extraction, and analysis, will be provided for the analyses. Data report forms will be securely bound and the pages will be sequentially numbered. The analytical reports for sample matrices will conform to the deliverable requirements included in Appendix QAPP-A. In addition to the hardcopy version of the analytical data packages, the laboratory will provide electronic deliverables.

15. Data validation

15.1. Methodology

15.1.1. Validation procedures

Data validation will be performed by O'Brien & Gere for data generated by STL-Envirotech. Data validation will be performed utilizing the QA/QC criteria established in this QAPP, as listed in Tables 10-1 to 10-4, the analytical methods, and/or the laboratory established criteria. Excursions from QA/QC criteria will be qualified based on guidance provided in the following documents or the most recent USEPA data validation guidelines:

- *USEPA Region III Modifications to National Functional Guidelines for Organic Data Review* (USEPA 1994c)
- *USEPA Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (USEPA 1993).

Data validators will recalculate a percentage of the laboratory sample calculations using raw data when verifying sample results. In addition, data validators will review raw data to verify that compound identification was performed correctly and transcription errors are not present.

Data quality will be evaluated using method or laboratory control limits. When possible, laboratory control limits will be evaluated against control limits established in the analytical methods. When method control limits are not available, professional judgement will be used by the data validators to verify that laboratory control limits will produce data of high quality. Any control limits outside of the acceptable range specified in the method shall be identified. Sample data will be qualified based on excursions from laboratory control limits. Data not within control limits require corrective action by the laboratory. Data validators will check corrective action reports and results of reanalysis if available.

Minor deficiencies in the data generation process noted in the data validation will result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical but not its assigned identity. Major deficiencies noted in the data validation will result in the rejection of sample results. Rejected data would be considered unusable for quantitative or qualitative purposes. Data qualifiers may include the following:

U Indicates that the compound was analyzed for, but was not detected. The sample quantitation limit is presented and adjusted for dilution and percent moisture. This qualifier is also used to signify that the detection limit of an analyte was raised as a result of analytes detected in laboratory and/or field blank samples.

J Indicates that the detected sample result should be considered approximate based on excursions from QA/QC criteria.

UJ Indicates that the detection limit for the analyte in this sample should be considered approximate based on excursions from QA/QC criteria.

R Indicates that the previously reported detection limit or sample result has been rejected due to a major excursion from QA/QC criteria, for example percent recoveries of less than ten percent. The analyte may or may not be present in the sample. The data should not be used for qualitative or quantitative purposes.

B The analyte was present but was not detected substantially above the level reported in the laboratory or field blanks.

K The analyte was present but the reported value may be biased high. The actual value is expected to be lower.

L The analyte was present but the reported value may be biased low. The actual value is expected to be higher.

If compounds are detected in blanks at concentrations greater than PQL, data will be qualified based on blank action levels calculated at five times (ten times for common laboratory contaminants) the highest concentration detected in the associated blanks. Samples collected, prepared, or analyzed in conjunction with contaminated blanks, which contain analytes less than calculated action levels will be qualified as blank contaminants and flagged with the "U" qualifier. For solid samples, the action level will be calculated taking into account preparation weights and volumes and percent solid determinations. Qualification of sample results will be based on date of analysis for calibration blanks, date of sample preparation for method blanks, and date of sample collection for trip and equipment blank samples.

The following method specific QA/QC parameters will be evaluated during the data validation, where applicable.

15.1.2. Analyses for VOCs

- Holding Times and Sample Preservation
- GC/MS Tuning Criteria
- Initial and Continuing Calibration
- Blank Analysis
- Surrogate Recovery
- MS/MSD Analysis
- Field Duplicate Analysis
- LCS Analysis
- Internal Standards Performance
- Compound Identification and Quantitation
- Reported detection limits
- System Performance
- Documentation Completeness
- Overall Assessment

15.1.3. Metals, TDS, TSS, TO analyses

- Holding Times and Sample Preservation
- Initial and Continuing Calibration
- Blank Analysis
- MS/MSD Analysis
- Field Duplicate Analysis
- LCS Analysis
- ICP Interference Check Sample Analysis
- ICP Serial Dilution Analysis
- Analyte Quantitation
- Reported detection limits
- Instrument Performance
- Documentation Completeness
- Overall Assessment

The laboratory will be conducting analyses on samples in accordance with methods in Table 10-1, the corrective action procedures in Tables 10-1 to 10-4, and the laboratory's QA Manual.

15.2. Reconciliation with user requirements

Validated sample results from the site will be reviewed by the Field Program Coordinator and the Project Manager. Data usability with respect to the data quality objectives and data uses will be compared to the project requirements. The parameters that will be used to assess the precision, accuracy, representativeness, comparability, and completeness are presented in Sections 4 and 10 of this QAPP. In the event that the completeness objective of 90% is not achieved due to major quality control deviations in the sample analysis process, samples will be recollected at the discretion of the Project Manager.

16. References

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APPENDIX QAPP-A

Laboratory data deliverable requirements

Contents

Contents

1. Table of contents

The deliverable data package should contain a table of contents. This table of contents should contain sufficient information to be a useful tool in locating sample result forms, quality control (QC) summary forms, and raw data for a specific analyses.

2. Case narrative

The case narrative should contain the following:

- A cross reference list which includes the field sample identification (ID) name, the laboratory ID number, and sampling dates for each sample in the sample delivery group (SDG) included in the data package;
- Documentation of the United States Environmental Protection Agency (USEPA) methodologies utilized to analyze the samples and references;
- Detailed documentation of QC, sample shipment, and analytical problems encountered in processing the samples for the data package; and,
- Documentation of reanalyses, internal QC processes used (for example, data provided in the data package but no used to generate sample results), corrective actions taken, and the resolution of the corrective actions taken.

3. Laboratory sample information sheets

A summary of the samples included in the SDG should be included in the data package. The summary should include the information contained in the cross reference list (described above), as well as a list of the analyses required for each sample in the SDG.

4. Chain-of-custody forms

The data package should contain copies of both external and internal chain-of-custody forms for the samples in the SDG. Internal chain-of-custody forms must document times when samples are signed out and back in, or if the entire sample was used in analysis.

5. Sample result summary forms

The sample results should be summarized on sample result summary forms [*i.e.*, similar to as EPA Contract Laboratory Program (CLP) Form I or equivalent] and included twice in the data package. One copy should be included in the beginning of the document after the chain-of-custody forms and the other copy should be included sample data section of the data package. The sample result forms in the sample data section of the data package should reflect only the results for the associated raw data presented in that section.

5.1. GC/MS sample result summary forms

Gas chromatograph/mass spectrometer (GC/MS) sample result summary forms should include the following information:

- Client name;
- Method ID;
- Lab name;
- Client sample ID;
- Lab sample ID;
- Lab file ID;
- Sample matrix;
- Amount of sample analyzed (*i.e.*, grams or milliliters);
- Extract volume;
- Soil aliquot volume [volatile organic compounds (VOCs) only];
- Injection volume [semi-volatile organic compounds (SVOCs) only];
- Percent Moisture;
- Method level analyzed (*i.e.*, low or medium);
- GPC cleanup (*i.e.*, yes or no) (SVOCs only);
- Dilution factor;
- Date sampled;
- Date of laboratory receipt;
- Date of analysis;
- Column ID;
- Concentration units; and,

- Columns of compounds, detected concentrations and/or quantitation limits, and qualifiers.

5.2. Metals sample result summary forms

Metals sample result summary forms should include the following information:

- Client name;
- Method ID;
- Lab name;
- Client sample ID;
- Lab sample ID;
- Lab file ID;
- Sample matrix;
- Percent solids;
- Date sampled;
- Date of laboratory receipt;
- Date(s) of analysis;
- Concentration units;
- Columns of analytes, detected concentrations and/or reporting limits, and qualifiers;
- Color and clarity of samples before digestion;
- Dilution factors; and
- Correction equations used by the data system to generate the sample results.

6. QC data

6.1. GC/MS QC data

GC/MS QC data section should include the following:

- Surrogate summary forms (*i.e.*, similar to CLP Form II or equivalent) which include method reference, sample IDs, surrogate compound ID, surrogate recoveries, surrogate recovery QC limits, and flagged surrogate recoveries outside the QC limits;

- Matrix spike/matrix spike duplicate (MS/MSD) and Laboratory fortified sample matrix/duplicate (LFM/LFMD) summary forms (*i.e.*, similar to CLP Form III or equivalent) which include method reference, sample ID, compound ID, concentration of original sample and spiked sample, spike concentration, percent recovery of the spike, relative percent difference (RPD), control limits for recoveries and RPDs, and flagged recoveries and/or RPDs outside the QC limits. Associated chromatography and quantitation reports for each of the analyses should also be included in the data package;

- Method/laboratory reagent blank summary forms (*i.e.*, similar to CLP Form IV or equivalent) which include method reference, method blank ID, matrix ID, date extracted, date and time of method blank analysis, method level utilized, instrument and column(s) utilized; and a list of the associated samples, blanks, standards and spikes by client and/or lab ID with associated time of analysis. Associated chromatography and quantitation reports for each method blank should also be included in the data package;

- Internal standards summary forms (*i.e.*, similar to CLP Form VIII or equivalent) including method reference, instrument and column(s) utilized, internal standard ID, internal standard areas and retention times of samples and 12-hour standards, upper/lower control limits, and flagged areas and/or retention times outside control limits; and,

- QC check standard [*e.g.*, laboratory control standard (LCS), laboratory fortified blank (LFB)] summary forms which include the method reference, instrument and column(s) utilized, QC check standard compound ID, concentration of QC check standard, results of the QC check standard analysis, percent recovery of the QC check standard, control limits, and flagged recoveries outside control limits. Associated chromatography and quantitation reports for each of the QC check standards should also be included in the data package.

6.2. Metals QC data

Metals QC data section should include the following:

- CRDL standard summary forms (*i.e.*, similar to CLP Form II - Part 2 or equivalent) which includes the CRDL standard true values, results (initial and final), percent recoveries, percent recovery control limits, and flagged CRDL standard recoveries outside the QC limits;

- Blank summary forms (*i.e.*, similar to CLP Form III or equivalent) including method/preparation blanks and initial/continuing calibration blanks results;

- For inductively coupled plasma (ICP) analyses, ICP interference check sample summary forms (*i.e.*, similar to CLP Form IV or equivalent) for A and AB solutions for all elements of interest (not only aluminum, magnesium, iron, and calcium), including true concentration values of solutions A and AB, concentrations found in solutions A and AB (initial and final analyses), and % recoveries of solution AB;

- For ICP analyses, ICP serial dilution summary forms (*i.e.*, similar to CLP Form IX or equivalent) which include initial sample and serial dilution results, percent difference (% D) results, and flagged % D outside QC criteria;

- MS summary (*i.e.*, similar to CLP Form V or equivalent) including concentrations of original sample, spiked sample and amount spiked, percent recoveries, percent recovery control limits, and flagged percent recoveries outside control limits, indicate predigestion spike;

- Post-digestion spike summary form (*i.e.*, similar to CLP Form V or equivalent) which includes the same information as the MS summary form, indicate post-digestion spike;

- Laboratory duplicate summary (*i.e.*, similar to CLP Form) including concentrations of original sample, duplicate sample, RPD, RPD control limits, and flagged RPDs outside control limits;

- LCS summary forms (*i.e.*, similar to CLP Form VII or equivalent) including the true concentrations of LCS, concentrations found, percent recoveries, a means of establishing standards traceability, control limits, and flagged percent recoveries outside the control limits;

- Instrument detection limits (quarterly) summary (*i.e.*, similar to CLP Form X or equivalent);

- ICP liner ranges (quarterly) summary form (*i.e.*, similar to CLP Form XII or equivalent);

- Raw data (*i.e.*, bench logs/sheets, instrument analysis reports, and/or strip charts) associated with the QC summary forms detailed above, with the exception of the instrument detection limits, ICP interelement correction factors, and ICP liner ranges; and

- Laboratory policy for evaluation of analytes above linear range; list of samples diluted as a result of the evaluation.

6.3. Inorganic QC data

Inorganic QC data section should include the following:

- Blank summary forms (*i.e.*, similar to CLP Form III or equivalent) including method/preparation blanks and initial/continuing calibration blanks results;

- MS/MSD summary (*i.e.*, similar to CLP Form V or equivalent) including concentrations of original sample, spiked sample and amount spiked, percent recoveries, percent recovery control limits, and flagged percent recoveries outside control limits;

- LCS summary forms (*i.e.*, similar to CLP Form VII or equivalent) including the true concentrations of LCS, concentrations found, percent recoveries, a means of establishing standards traceability, control limits, and flagged percent recoveries outside the control limits; and

- Raw data (*i.e.*, real-time data such as bench logs/sheets and/or strip charts) associated with the QC summary forms detailed above.

7. Calibration data

7.1. GC/MS calibration data

GC/MS calibration data should include the following:

- Instrument performance check (*i.e.*, BFB or DFTPP tuning data) summary forms (*i.e.*, similar to CLP Form V or equivalent) which include method reference, instrument and column(s) utilized, date and time of instrument performance check analysis, method level utilized, individual ion ID/ion abundance criteria/ % relative abundance, flagged data outside the criteria; and a list of the associated samples, blanks, standards and spikes by client and/or lab ID with associated date and time of analysis. Associated bar graph spectrum, mass listing, and reconstructed total ion chromatogram should also be included in the data package;

- Initial calibration summary forms (*i.e.*, similar to CLP Form VI or equivalent) which include method reference, instrument and column(s) utilized, calibration date(s) and times, identification of calibration standard concentrations, compound ID, relative response factors (RRFs) for each standard, average RRF, percent relative standard deviation (% RSD) of initial calibration standards, minimum RRF and maximum %RSD criteria, and flagged RRFs or % RSDs outside the QC criteria, if calibration curve used, provide curve and evaluation;

- Continuing calibration summary forms (*i.e.*, similar to CLP Form VII or equivalent) which include method reference, instrument and column(s) utilized, continuing calibration dates and times, identification of continuing calibration standard concentrations, compound ID, average RRFs from the associated initial calibration, continuing calibration standard RRFs, % D from the initial calibration average RRFs, minimum RRF and maximum %D criteria, and flagged RRFs or %Ds outside the QC criteria;

- An initial calibration packet for each instrument used to analyze samples in the SDG containing initial calibration summary forms and associated chromatography and quantitation reports for each of the initial calibration standard concentrations; and

- A continuing calibration packet for each instrument used to analyze samples in the SDG containing a continuing calibration summary forms and associated chromatography and quantitation reports for each of the continuing calibration analyses.

- Analysis run logs (with reported runs marked);

- Example calculations for response factors.

7.2. Metals calibration data

Metals calibration data should include the following:

- Initial and continuing calibration verification (ICV and CCV) summary forms (*i.e.*, similar to CLP Form II - Part 1 or equivalent) which include the ICV and CCV true values, results, percent recovery, percent recovery control limits, and flagged ICV or CCV recoveries outside the QC limits.

- Raw data (*i.e.*, real-time data such as bench logs/sheets, instrument analysis reports and/or strip charts) associated with the ICV and CCV standards.

- Analysis run logs (with reported runs marked).

7.3. Inorganic calibration data

Inorganic calibration data should include the following:

- Initial calibration data clearly presented on bench logs including the concentrations of standards, instrument responses (e.g., absorbance), and correlation coefficients

- CCV standards clearly presented on bench logs including the true value of CCV standards, instrument responses, resulting concentrations, and percent recoveries

- Raw data (*i.e.*, real-time data such as bench logs/sheets, instrument analysis reports and/or strip charts) associated with the initial calibration and CCV standards.

- Analysis run logs (with reported runs marked)

8. Sample data

8.1. GC/MS sample data

GC/MS sample data should include the following:

- Sample result forms (as described in Section 5);
- Sample result forms for the diluted and undiluted samples (as described in Section 5);
- Extraction logs (where applicable);
- Analysis run logs (with reported runs marked);
- Chromatography and quantitation reports for each sample (diluted and undiluted) with a header that includes the date and time of analysis, client and lab sample ID, instrument and column ID, and laboratory file ID; and
- Mass spectra for the detected compounds in the samples (raw spectra, background subtracted and reference spectra for each compound).

8.2. Metals sample data

Metals sample data should include the following:

- Sample result forms (as described in Section 5);
- Preparation log summary forms (*i.e.*, similar to CLP Form XIII or equivalent) for each analyte which include method ID, client sample ID, preparation date, weight (gram), and volume (mL);

Health and Safety Plan for the Bishop Tube Site

Christiana Metals Corporation
Frazer, Pennsylvania

May 1999

O'BRIEN & GERE
ENGINEERS, INC.

3552.009

Interim Remedial Action Workplan Appendix B

Health and Safety Plan for the Bishop Tube Site

Christiana Metals Corporation
Frazer, Pennsylvania

May 1999

O'BRIEN & GERE ENGINEERS, INC.

O'Brien & Gere Engineers, Inc.
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Contents

Figures

Exhibits

1. General

1.1. Scope and purposes

The scope of work as provided by the Interim Remedial Action Workplan for the Site is to characterize and evaluate ground water quality data, and to update the conceptual Site model with respect to potential source areas, ground water flow conditions and apparent VOC migration. The purposes of this HASP are to identify and evaluate the potential on-site hazards and to select the appropriate protective equipment required for the work activities.

The requirements and guidelines presented in this HASP are based on a review of available information and an evaluation of potential on-site hazards. This HASP incorporates by reference the applicable Occupational Safety and Health Administration (OSHA) requirements in 29 CFR Part 1910 and 29 CFR Part 1926. The protective equipment selection was made in accordance with Subpart I of 29 CFR 1910. O'Brien & Gere personnel are required to read this HASP before beginning work on site. This HASP will be available for inspection and review by O'Brien & Gere employees while work activities are underway. When conducting the activities associated with implementation of the workplan, O'Brien & Gere personnel will comply with this HASP. On-site O'Brien & Gere personnel will notify the O'Brien & Gere Site Safety and Health Coordinator (SSHC) of matters of health and safety. The SSHC is responsible to the Project Manager for monitoring activities, monitoring compliance with the provisions of this HASP, and for modifying this HASP to the extent necessary if site conditions change. This HASP is specifically intended for the conduct of O'Brien & Gere activities defined in the workplan in the areas of the site specified for these work activities. Although this HASP can be made available to interested persons for informational purposes, O'Brien & Gere does not assume responsibility for the interpretations or activities of any persons or entities other than employees of O'Brien & Gere and its subcontractors.

1.2. Health and safety personnel

Implementation of HASP requirements will be directed by O'Brien & Gere personnel with the following health and safety designations and general responsibilities. The specific personnel for this program are provided in Section 9.

1.2.1. Health and safety manager

The HSM is identified in Section 9 of the HASP. The HSM has final authority to resolve health and safety issues that are not resolved at the Site or through the Health and Safety Supervisor ("HSS"), and has overall responsibility for ensuring that the policies and procedures of this HASP are implemented by the Health and Safety Coordinator ("HASC").

1.2.2. Health and safety supervisor

The HSS is identified in Section 9 of the HASP. The HSS is the health and safety professional who will serve as the HSM's designee for this project. The HSS will be responsible for:

- Designating the HASC
- General supervision of implementation of the HASP for this work plan
- General supervision of significant changes to the HASP for this work plan
- Resolution of Site disputes involving health and safety issues

The HSS will notify the HSM of Stop Work Orders issued by an HASC.

1.2.3. Health and safety coordinator

The HASC's office location and telephone number is identified in Section 9 of the HASP. The person assigned as the HASC at the Site is to be approved by the HSS. The duties of the HASC will be as follows:

- Implementation of the HASP in accordance with the Health and Safety Program.
- Conducting safety inspections.

- Inspection of accidents, illnesses and incidents occurring on-site.
- Conducting safety briefings and Site-specific training for on-site personnel.
- Accompany NJDEP Occupational Safety and Health Administration ("OSHA"), or other governmental agency personnel visiting the Site in response to health and safety issues.
- Updating and modifying the HASP for the Site in consultation with the HSS due to changes in Site or environmental conditions.

The HASC is given the authority to stop Site operations (STOP WORK AUTHORITY) if the HASC determines that an imminent health or safety hazard or other potentially dangerous situation exists. The HASC is to immediately notify the HSS of Stop Work Orders when they are issued. The HASC may also recommend to the HSS or HSM that work authorization for individual Site personnel be revoked due to health and/or safety concerns.

The HASC will document that personnel entering the work areas at the Site are qualified in accordance with the requirements of 29 CFR 1910.120 and this HASP.

1.3. Training

Training requirements as provided by the Health and Safety Program and 29 CFR 1910.120, will be required for personnel entering work areas at the Site. Personnel working on the site must have completed the 40 hour hazardous waste training course and a hazardous waste refresher course within the last twelve months. Personnel without required training certification will not be permitted in work areas at the Site.

1.4. Medical surveillance program

O'Brien & Gere has implemented a medical monitoring program in accordance with 29 CFR 1910.120. The O'Brien & Gere program is designed to monitor and reduce health risks to employees potentially exposed to hazardous materials and to provide baseline medical data for each employee involved in work activities. It is also designed to determine the employee's ability to wear personal protective equipment such as chemical resistant clothing and respirators.

Medical examinations are administered on a post-employment and annual basis and as warranted by symptoms of exposure or specialized activities. The examining physician is required to make a report to O'Brien & Gere of any medical condition that would increase the employee's risk when wearing a respirator or other PPE. O'Brien & Gere maintains site personnel medical records as required by 29 CFR 1910.120 and by 29 CFR 1910.1020, as applicable.

O'Brien & Gere employees performing the activities listed in the workplan have or will receive medical tests as regulated by 29 CFR 1910.120. Where medical requirements of 29 CFR 1910.120 overlap those of 29 CFR 1910.134, the more stringent of the two will be enforced.

1.5. Respirator clearance

Employees who wear or may wear respiratory protection have been provided respirators as required by 29 CFR 1910.134. This standard requires that an individual's ability to wear respiratory protection be medically certified before performing designated duties.

2. Site characterization and analysis

2.1. Site description

The Site is located in Frazer, in Chester County, Pennsylvania.

2.2. Scope of work

The work activities which may be performed under this HASP will consist of the following:

Well Drilling - MW-21

- one boring advanced to approximately 55 ft bg
- continuous split-spoon sampling of soils during drilling
- UV fluorescence and PID screening of split spoon samples
- soil selection for laboratory analysis of VOCs (based on screening)
- 10-inch casing set to 18 ft bg
- 6-inch casing set to 35 ft bg
- conversion of boring to a 6-inch, open-hole monitoring well/extraction well
- collection and inspection of rock drill cuttings
- grab ground water sample collection after casing installations and well development

Well Drilling - MW-22

- one boring advanced to approximately 95 ft bg
- continuous split-spoon sampling of soils during drilling
- UV and PID screening of split spoon samples and drill cuttings
- soil selection for potential laboratory analysis
- 10-inch casing set to 18 ft bg
- 6-inch casing set to 70 ft bg
- conversion of boring to a 6-inch, open hole monitoring well

- optional use of larger casings (14-inch and 10-inch casings) and third 6-inch diameter casing
- collection and inspection of rock drill cuttings
- grab ground water sample collection after casing installations and well development

Piezometer installations (PZ-1/PZ-2)
- borings advanced to the overburden bedrock interface (PZ-1), and into bedrock (PZ-2)
- continuous split spoon sampling of overburden soils
- UV fluorescence and PID screening of split spoon samples
- soil selection for potential laboratory analysis of VOCs
- for PZ-2, installation of 6-inch diameter casing, 3 ft into rock
- conversion of borings to 2-inch diameter PVC piezometers
- collection and inspection of drill cuttings
- piezometer development

Ground Water/Surface Water Sampling
- ground water sampling from existing monitoring wells
- ground water sampling from newly installed monitoring wells/piezometers
- ground water sampling from one residential water supply well
- additional ground water sampling and pretreatment/post-treatment water sampling during the hydraulic containment/treatment pilot testing
- collection of surface water samples

Hydraulic monitoring
- measurement of ground water levels periodically (initially monthly) in Site monitoring wells and piezometers
- measurement of surface water (stream) levels in Little Valley Creek
- additional hydraulic monitoring to be conducted during the hydraulic containment pilot testing

Investigation-derived waste (IDW) management
- containerization of IDW including: drill cuttings/fluids, development water, decontamination fluids, purged ground water, spent carbon during pilot testing and other IDW generated
- characterization of IDW as necessary for disposal and/or treatment

This HASP does not cover activities other than those specifically listed above. Other possible work activities not described above may only be conducted after approval of an appropriate addendum to this HASP by the HSM.

2.3. Initial site entry

Based on existing information about the Site and a Site walk through, initial field activities in work areas at this Site will be conducted in Modified Level D personal protective equipment ("PPE"). Monitoring of the breathing zone will at a minimum be conducted using a PID for VOCs, subject to response levels identified in Section 5.2. Real-time monitoring instrumentation will be used to assist in verifying the determination that the initial level of protection is appropriate for the initial Site entry team.

2.4. Site hazards

An assessment of the hazards has been made for each of the activities specified. Suspected physical, biological, chemical, flammable, explosive and reactive hazards were evaluated. The following paragraphs summarize the potential risks that have been identified.

For the activities listed in Section 2.2, the following hazards have been identified:

- physical hazards associated with the use of the sampling and support equipment
- biological hazards such as mosquitos and ticks
- skin and eye contact with constituents of concern
- ingestion of constituents of concern, if any
- inhalation of low concentrations of organic vapors

2.4.1. Health hazards due to chemicals

The substances most likely to be encountered at the Site are trichloroethlene (TCE), 1,1,1-trichloroethane (1,1,1-TCA) and possibly vinyl chloride. The Material Safety Data Sheets (MSDs) for these compounds are included in Exhibit 1.

Trichloroethene (TCE)
TCE is a hazardous substance due primarily to its toxicity. Effects result from both high-level, acute and lower-level, chronic exposures. The primary potential path of exposure, if present, from this Site is through inhalation; however, TCE is also toxic through dermal exposure and ingestion. Effects include restlessness, impaired concentration, irritability, euphoria, hallucinations, bronchial constriction, pulmonary edema, fatal cardiac arrhythmias, renal and hepatic damage. The predominant physiologic response is one of CNS depression. Direct eye contact produces injury to the corneal epithelium with recovery within a few days. TCE is mildly irritating to the skin. Higher concentrations, including vapor exposure, may result in chemical burns.

The estimated fatal ingested dose in humans is reported to be 3 to 5 milliliters/kilogram. The ethereal, chloroform-like odor of TCE is detectable at 50 ppm, with levels above 200 ppm becoming disagreeable. The TLV for TCE is 50 ppm with a short term exposure limit (STEL) of 100 ppm. These levels are usually mitigated through local exhaust (pressure/vacuum) ventilation. When the vapor concentration exceeds 50 ppm, a respirator with an organic vapor cartridge is required. The potential fire hazard from TCE alone is low. TCE is non-corrosive.

Protection must be afforded against both dermal contact and inhalation. Skin and eye contact with some of the contaminants which may be present at the Site may cause skin or mucous membrane irritation. Many of these compounds can be absorbed into the bloodstream through the skin or eyes.

2.4.2. Safety hazards
There is a risk of physical injury resulting from contact with heavy equipment. Field personnel should be aware of the presence of these hazards and take steps to avoid contact with them.

2.4.3. Biological hazards
Numerous types of pest organisms may be present, including mosquitos and ticks. Exhibit 4 presents a discussion of Ticks and Tick-Borne Diseases.

2.4.4. Flammable hazards
Flammable hazards may exist during the course of this project due to the presence of flammable materials associated with drilling equipment..

2.5. Site hazard controls

2.5.1. Health hazards due to chemicals

Any body area which comes in contact with waste materials should be washed with soap and rinsed immediately. Field personnel should report skin or eye contact symptoms to the HASC. The person should be treated by a medical professional and steps should be taken to eliminate similar exposures. An emergency eye wash station will be present at the Contamination Reduction Zone.

Potential hazards will be minimized by protecting against exposures to hazardous materials via utilization of appropriate PPE. PPE to protect the body against contact with known or anticipated chemical hazards has been divided into five levels of protection categories (Level A, B, C, Modified D, and D) according to the degree of protection afforded.

The level of protection selected for the activities at the Site, as specified in Section 4, is Modified Level D. This level of protection was selected because the types of airborne substances will be known and the concentrations will be monitored.

Initial and periodic air monitoring will be employed to assess respiratory hazards in the work zones for work activities as appropriate. Although the use of respiratory protective equipment is not anticipated, full-face respirators with organic vapor/acid mist cartridges and high-efficiency dust filters, as defined in Section 4, will be available in case respiratory hazards are deemed to be present based on air monitoring results.

Dermal protection is accomplished by routinely wearing neoprene constructed gloves, worksuit, apron, and shoes. Safety goggles or a face shield is necessary to protect against splash potential. If exposed, eyes should be immediately washed with large amounts of water, occasionally lifting the lower and upper lids. Contact lenses should not be worn. Contaminated skin should be promptly washed with soap and water. If this chemical penetrates the clothing, promptly remove the clothing and wash the skin with soap and water. If inhaled, the exposed person should be moved to fresh air at once. Keep the affected person warm and at rest. In all cases, medical attention should immediately be sought.

Ingestion of chemical hazards will be controlled on this Site by prohibiting any eating or smoking in the Exclusion Zone (see Section 3) and by requiring field personnel to decontaminate themselves upon leaving the Exclusion Zone. Drinking of liquids should take place only after partial decontamination has taken place, except in a heat stress emergency situation. Drink breaks should be scheduled at least every 2 hours to avoid heat stress problems.

Levels of protection can be upgraded or downgraded by the HASC if they are not appropriate.

2.5.2. Safety hazards
Exhibit 2 presents Safety Guidelines for Drilling.

Use of steel-toe boots with steel shanks and hard hats (if overhead hazards exist) will be required when in the work zone. Personnel should be cognizant of the fact that when PPE such as respirators, gloves, and protective clothing is worn, visibility, hearing, and manual dexterity are impaired.

In addition, the PPE required for some activities (coveralls and respirators) places a physical strain on the wearer. The Heat Stress Casualty Prevention Plan as specified in Exhibit 3 will be implemented to deal with this health hazard during warm weather. The plan outlines heat stress identification, treatment, prevention and monitoring. Fluids will be provided at regular intervals during the work periods in order to maintain adequate body fluid levels for the field personnel.

2.5.3. Biological hazards
Field personnel are encouraged to use insect repellents before donning PPE if deemed necessary. A first aid kit and insect repellent will be available for use in the field. In many parts of the northeast United States, tick-borne diseases pose a significant health risk during warm months. Exhibit 4 presents a discussion of Ticks and Tick-Borne Diseases.

2.5.4. Flammable hazards
Air quality monitoring as specified in Section 5 will be conducted continuously during drilling activities.

3. Site Control

3.1. Zone control

Areas of the Site at which Workplan field work activities will be conducted will be subdivided into three zones: an Exclusion Zone ("EZ"), a Contamination Reduction Zone ("CRZ"), and a Support Zone ("SZ"). These zones will be maintained according to the requirements of this HASP and of OSHA regulations provided in 29 CFR 1910.120. A log of personnel entering the work areas at the site will be maintained by the HASC or a designee.

3.1.1. Exclusion zone

The EZ isolates the area of subsurface investigation. The EZ serves to restrict the spread of potential contamination from work areas of the Site to support areas and off-site locations. The EZ is demarcated by a tape line, demarcation cones or physical barrier. Personnel entering the EZ must:

- Enter through the CRZ
- Wear the prescribed level of protection (see Section 4.2.)
- Be otherwise authorized to enter the EZ (see Section 1.03, 1.04, and 9.01).

Personal protective equipment or other contaminated materials exiting the EZ will be deemed to require decontamination. Equipment and materials will either be subject to decontamination or containerized in uncontaminated devices for decontamination or disposal at the designated off-site location.

Within the EZ, specific locations or restricted areas (clearly marked or identified) will be established as necessary for particular locations or around specific Site operations. Specific access for emergency services to areas of Site operations will be established.

3.1.2. Contamination reduction zone

The CRZ is a transition zone between the EZ and SZ. It is designated by a tape line between the EZ and the beginning of the CRZ and by a control line between the CRZ and the SZ. Field personnel, equipment, or materials which leave the work area require decontamination. After undergoing the decontamination process or containerization, personnel equipment, or materials will be permitted to exit the CRZ.

Within the CRZ is the Contamination Reduction Corridor ("CRC"), where materials necessary for field personnel and portable equipment decontamination, and certain safety equipment associated with normal work-related incidents are staged.

3.1.3. Support zone

An SZ will be established adjacent to the CRZ and will contain the necessary support facilities (including personal hygiene facilities) for Site operations. It also serves as the communications center and source of emergency assistance for operations in the EZ and CRZ.

3.2. Medical assistance

Medical assistance may be obtained at the Paoli Memorial Hospital (610) 648-1000. Additional information is provided in Section 7.8. of this HASP.

3.3. Site security

Site security will be monitored and controlled by the Project Manager, the Site Supervisor, and the HASC. Their duties will include limiting access to the work area to authorized personnel, overseeing project equipment and materials, and overseeing work activities. The procedures specified below will be followed to control access to each work site and to minimize the potential for a person who may be unaware of site conditions from exposure to hazards. O'Brien & Gere will coordinate all activities with the Bishop Tube Site contact. Work area control procedures may be modified as required by site conditions.

3.4. Site access procedures

Access during field activities will be limited to those personnel required. Such personnel are anticipated to include, but will not necessarily be limited to, O'Brien & Gere employees or subcontractors and those representatives as designated by Bishop Tube and state or local agencies. Site access will be monitored by the HASC, who will maintain a log-in sheet. The log will include O'Brien & Gere and other personnel on the site, their arrival and departure times and their destination on the site.

O'Brien and Gere personnel leaving an exclusion zone will be decontaminated in a contaminated reduction corridor before entering the support zone. The Project Manager and the HASC will establish decontamination locations for each site. The layout of the zones, the procedures to be followed for zone control, and the signs used to indicate the zones will be reviewed during the daily safety briefings before beginning the day's work.

3.5. Site communication

A cellular telephone will be used during activities to facilitate communications for emergency response and other purposes and to serve as the primary off-site communication network. Radios will be available and used also.

4. Work practices and personal protective equipment

4.1. Work practices

Workers will adhere to established safe work practices for their respective specialties. The need to exercise caution in the performance of specific work tasks is made more acute due to:

- weather conditions
- restricted mobility and reduced peripheral vision caused by the PPE itself
- increased difficulty communicating due to respirators, if required.

Work at the Site will be conducted according to established protocols and guidelines for the safety and health of all involved. Among the most important of these principles for working at a potentially hazardous waste site are the following:

- In unknown situations, assume the worst conditions and plan accordingly

- Use the buddy system. Under no conditions will personnel be permitted to enter the EZ alone. Establish and maintain communication. In addition to radio communications, it is advisable to develop a set of hand signals, because conditions may impair verbal communications.

- Because no PPE is 100 percent effective, personnel must minimize contact with excavated or contaminated materials. Plan work areas, decontamination areas, and procedures accordingly. Do not place equipment on drums. Do not sit on drums or other materials. Avoid standing in or walking through puddles or stained soil.

- Smoking, eating, drinking, chewing tobacco, gum or toothpicks, applying cosmetics, storing food or food containers, and having open fires shall not be permitted within the EZ or CRZ. Good personal hygiene should be practiced by field personnel to avoid ingestion of contaminants.

- Approach or entry into areas or confined spaces where toxic or explosive concentrations of gases or dusts may exist without proper equipment is prohibited. No confined space entry is anticipated at this Site.

- Avoid heat and other work stresses related to wearing protective gear. Work breaks should be planned to prevent stress-related accidents or fatigue.

- Field personnel must inform the HASC before entering the Site. IF DRUMS OR OTHER PREVIOUSLY UNIDENTIFIED POTENTIAL HAZARDS ARE DISCOVERED DURING ANY FIELD WORK, SECURE THE AREA, LEAVE IMMEDIATELY AND CALL THE PROJECT OFFICER AND HSM FOR FURTHER INSTRUCTIONS.

- Personnel must be aware of not only their own immediate environment but also those of others. A team effort is required to detect and alert personnel of impending dangerous situations. Extra precautions are necessary when working near heavy equipment and while utilizing personal protective gear because vision, hearing, and communication can be restricted.

- Rigorous contingency planning and dissemination of plans to personnel minimizes the impact of rapidly changing safety protocols in response to changing Site conditions.

- Be aware that compounds of concern may mimic or enhance symptoms of other illnesses or intoxication. Avoid working while ill during field investigation assignments. Consumption of alcohol during work hours is strictly prohibited.

- The HASC and sampling personnel will maintain project records in a bound notebook (i.e., daily activities, meetings, incidents, and data). Notebooks will remain on-site for the duration of the project so that replacement personnel may add information, thereby maintaining continuity. These notebooks and daily records will become part of the permanent project file.

- Whenever possible, field personnel should work in a position upwind of intrusive work activities.

- The PPE specified in this plan must be provided to field personnel. The following requirements are in accordance with OSHA regulations:

  - facial hair that interferes with proper fit of respirators must not be present; and,
  - eyeglasses that interfere with proper fit of full-face respirators must not be worn.

4.2. Personal protective equipment

The initial level of protection at the Site is Level D based on previous monitoring. However, protective equipment may be upgraded depending upon the monitoring results and the work activity being performed. It is anticipated that Level D PPE will be used for water level measurements and for other minimally intrusive work activities. A minimum of Modified Level D PPE will be used for ground water sampling, drilling activities and other subsurface investigations.

The following descriptions provide the basic composition of the generally recognized protective ensembles to be used for Site operations. Specific components for levels of protection will be selected based on hazard assessment; additional elements will be added as necessary. Disposable protective clothing, gloves, and other equipment, exclusive of respirators, should be used when feasible to minimize risks during decontamination and possible cross-contamination during sample handling.

Level D Personal Protective Equipment

- Long sleeve shirts/long pants or coveralls
- Hard hat (if overhead hazard exists such as during drilling)
- Hearing protective equipment (if noise hazard exists such as during drilling)
- Safety glasses or goggles
- ANSI-approved Steel-toed and steel shank work boots
- Nitrile - butadiene rubber outer gloves (to be worn over surgical gloves)(1)
- Latex/nitrile surgical gloves(2)

(1) Optional, at discretion of HASC.
(2) to be worn during sampling activities.

Modified Level D Personal Protective Equipment

- Long sleeve shirts/long pants or coveralls
- Hard hat (if overhead hazard exists such as during drilling)
- Hearing protective equipment (if noise hazard exists such as during drilling)
- Safety glasses or goggles
- ANSI-approved Steel-toed and steel shank work boots
- Nitrile-butadiene rubber outer gloves (to be worn over surgical gloves)
- Latex/nitrile surgical gloves
- Tyvek coveralls (taped at cuffs)
- Rubber overboots or disposable "booties"

Level C Personal Protective Equipment

- Long sleeve shirts/long pants or coveralls
- Hard hat
- Hearing protective equipment (if noise hazard exists such as during drilling)
- Full-face MSA NIOSH-approved respirator with GMC-H combination cartridges
- Steel-toes ANSI-approved and steel shank work boots
- Nitrile - butadiene rubber outer gloves (to be worn over surgical gloves)
- Latex surgical gloves
- Rubber overboots or disposable "booties"
- Tyvek coveralls or Saranex impregnated Tyvek coveralls (taped at cuffs)

In addition to these items, air monitoring equipment described in Section 5 must be provided. A list of personal protective equipment is included as Exhibit 7.

4.3. Respirator maintenance

Respirators shall be cleaned daily, if used, according to procedures prescribed by the manufacturer. Combination cartridges will be used and replaced either daily or if breakthrough is detected at any time while in use. Negative pressure tests will be performed daily on each individual respirator. The following checks shall be performed on a daily basis in addition to the above:

- Exhalation valve - pull off plastic cover and check valve for debris or for tears in the neoprene valve (which could cause leakage);

- Inhalation valves (two) - screw off cartridges and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place;

- Make sure protective lens cover is attached to the lens. Lenses are expensive to replace and should be protected;

- Make sure you have the right cartridge;

- Make sure that the face piece harness is not damaged. The serrated portion of the harness can fragment with will prevent proper face seal adjustments; and,

- Make sure the speaking diaphragm retainer ring is hand tight.

4.4. Protective equipment failure

If an individual experiences a failure or other alteration of PPE that may affect its protective ability, that person is to leave the work area immediately. The Project Manager or the HASC must be notified and, after reviewing the situation, are to determine the effect of the failure on the continuation of on-going operations. If the Project Manager or the HASC determine that the failure affects the safety of workers, the work site, or the surrounding environment, workers are to be evacuated until corrective actions have been taken. The HASC will not allow re-entry until the equipment has been repaired or replaced and the cause of the failure has been identified.

5. Monitoring

VOCs may be present in the investigation areas at the Site. Real time monitoring of these substances will be conducted on-site by, or under the supervision of, the HASC. The HASC will evaluate whether the personal protective measures employed during field activities are appropriate and will modify the protective measures accordingly. Field personnel will record readings in a notebook at the site. The HASC will be responsible to maintain monitoring instruments throughout the investigation.

Personal monitoring must be conducted in the breathing zone and, if workers are wearing respiratory protective equipment, outside the face piece. Monitoring in the breathing zone of the worker in the EZ must be performed continuously. However, this monitoring strategy may change if the operation or tasks change in the work areas, or if exposures potentially decrease as dictated in the HASP.

5.1. Field instrumentation and calibration

On-site air monitoring at the Site will include the use of a PID and direct-reading colorimetric indicator tubes.

5.1.1. Photoionization detector (PID)

Hazard Monitored: Many organic and some inorganic gases and vapors

Application: Detects the presence and total concentration of many organic and some inorganic gases and vapors

Detection Method: Ionizes molecules using UV radiation, produces a current that is proportional to the number of ions present

General Care and Maintenance: Recharge daily or replace the battery. Regularly clean the lamp window. Regularly clean and maintain the instrument and its accessories. Turn the function switch to "stand-by" and allow the instrument to "warm up" for 5 min. Calibrate once a day using an isobutylene gas standard according to the manufacturer's instructions. Repeat the procedure to validate calibration.

Typical Operating Time: 10 hr, 5 hr with strip chart recorder.

5.1.2. Colorimetric indicator tubes

Hazard monitored: vinyl chloride, trichloroethene

Application: provides direct reading compound-specific identification and relative quantification by drawing air via hand-held bellow pump through a sorbent tube which yields a color change in the presence of the compound of interest

Detection method: colorimetric reaction that occurs over a graduated scale, indicating the relative concentration of the compound detected

General care and maintenance: colorimetric tubes must be those with a range of 0.5 - 5 ppm; (this range is for the Drager brand; for other brands, a scale starting below 1.0 ppm is required). Pump should be checked for air leaks, and stroke counter re-set to zero before each use. Keep all equipment dry. Check the shelf-life date on the tubes. Follow storage instructions on the tube containers.

Typical operating time: hand-operated pump - no limit. Battery operated pump - several hours.

The breathing zone will be monitored with colorimetric indicator tubes to assess the potential presence of vinyl chloride. Each tube will be opened at each end, inserted (arrow pointing in) into the bellows pump, and the indicated number of strokes completed. The concentration is read on the scale according to the color change in the tube's sorbent media.

5.1.3. Combustible gas monitor

Hazard Monitored: Combustible gases and vapors

Application: Measures the concentration of combustible gases or vapors

Detection Method: One method uses a filament, usually made of platinum, that is heated by burning the combustible gas or vapor. The increase in heat is measured. Another method ionizes gases and vapors in a flame. A current is produced in proportion to the number of carbon atoms present.

General Care and Maintenance: Recharge daily or replace the battery. Calibrate immediately before use.

Typical Operating Time: 10 to 12 hours on one battery charge.

5.2. Air monitoring

The air will be monitored with a portable PID to determine the presence and concentration of organic vapors during sampling activities. Breathing zone monitoring with colorimetric indicator tubes will be conducted during work activities as specified below. The sampling strategies described below may change if work tasks or operations change. Monitoring instruments will be checked for appropriate response, in accordance with the manufacturer's instructions, before use each sampling day.

5.2.1. PID monitoring

The air will be monitored with a portable PID equipped with a 10.2 electron volt detector to determine the presence and concentration of VOCs. Samples will be taken before starting work activities and, if the action levels are exceeded, continuously in the breathing zone of the worker and recorded at approximately 5-minute intervals. The PID will be checked for positive and accurate response to a predetermined concentration of isobutylene in accordance with the manufacturer's instructions before use each sampling day.

5.2.2. Colorimetric monitoring

Colorimetric monitoring using indicator tubes will also be conducted if necessary based on the PID monitoring and action levels (Section 5.4.1). Colorimetric tubes will be used for organic vapor monitoring in accordance with manufacturer's specifications.

5.2.3. CGM monitoring

The air will be monitored with a CGM before beginning work activities to determine the presence and concentration of combustible gases and vapors.

The CGM will be programmed to sound an alarm when the combustible gas concentration exceeds 10% of the Lower Explosive Limit (LEL) for methane. The CGM will be checked for appropriate response before use each field day in accordance with the manufacturer's instructions.

5.3. Quality control - field sampling

The HASC, or someone under the direct supervision of the HASC, will collect field monitoring data (PID, colorimetric tubes), CGM. Bound log books and appropriate data sheets will be used to document the collection of the field monitoring data so that an individual data set can be traced to its point of origin, the sampler, and the sampling equipment used. Sampling will be performed according to the manufacturer's instructions.

5.4. Action levels

Action levels are used to determine when activities should stop, to determine when site evacuation is necessary, to select emergency response levels, and to change PPE levels.

5.4.1. Organic vapors

Breathing zone monitoring with a PID will be done at approximately 15 minute intervals during work activities and will be increased to 5 minute intervals starting at the time that the VOC level in the work area exceeds 10 ppm above background concentrations. Actions, such as increasing ventilation, will be implemented to promote dispersion of the vapors. Air purifying respirators and chemical resistant clothing will be donned by the workers when the VOC concentration in the respective breathing zone exceeds 25 ppm above the background for a period greater than 5 minutes as indicated on the PID. If the measured VOC concentration is greater than or equal to 250 ppm, the workers will leave the work area until the concentrations of the compound fall below 200 ppm.

The organic vapor level will be measured upwind and downwind of the work area, at approximately 30 minute intervals, whenever air purifying respirators are being worn. If the downwind concentration exceeds the upwind concentration by more than 10 ppm, work on the site will stop until the downwind concentration is less than 10 ppm greater than the upwind concentration.

In addition, breathing zone monitoring with colorimetric indicator tubes will be conducted during the work activities when there is a breathing zone reading of 1 ppm or greater on the PID. The action level for trichloroethene is 1.0 ppm; the action level for vinyl chloride is 1 ppm. Detection of 1.0 ppm or greater of vinyl chloride or trichloroethene requires donning air purifying respirators with organic vapor cartridges, and continued monitoring. Detections of 10 ppm vinyl chloride or trichloroethene requires evacuation from the work area until concentrations decrease.

5.4.2. Combustible gas

Explosive levels of gases and vapors may be encountered during drilling activities and may accumulate in wellheads prior to ground water sampling activities. A CGM will be used when wellheads are opened to determine the level of combustible gas. An action level of 10% of the LEL for methane will be used. Work will cease at any location where the explosive gas reading exceeds 10% of the LEL of methane. Actions, such as increasing ventilation, will be taken to disperse the contaminant from that area. If the combustible gas level does not decrease within 10 min, the SSHC will contact the Project Manager for assistance. Although personnel are not required to vacate the area until the LEL reaches 10%, they may not return until the LEL is lower than 10%.

6. Decontamination/disposal

Personnel and/or equipment leaving the Site work areas are to be decontaminated.

6.1. Personnel decontamination

Decontamination procedures are followed by personnel leaving Site work areas. Decontamination of personnel will take place only in the CRZ. Only under emergency evacuation circumstances will personnel be allowed to leave the Site work areas prior to decontamination. Generalized procedures for removal of protective clothing are as follows:

1. Drop tools, monitors, samples, and trash at designated drop stations (i.e., plastic containers or drop sheets).

2. Step into the designated shuffle pit area and scuff feet to remove gross amounts of dirt from outer boots.

3. Scrub outer boots and outer gloves with decontamination solution or detergent and water in tub. Rinse with water in tub and discard water in on-site holding tank.

4. Remove tape from outer boots and remove boots; discard in on-site holding tank.

5. Remove tape from outer gloves and remove gloves; discard in disposal container.

6. If the worker has left the exclusion zone to change the air tank on his/her SCBA, or the canister on his/her air purifying respirator, this is the last step in the decontamination procedure. The tank or cartridge should be exchanged, new outer gloves and boot covers donned, the joints taped, and the worker returned to duty,

7. Remove outer garments and discard in the disposal container.

8. Remove respirator and place or hang in the designated area.

9. Remove inner gloves and discard in the disposal container.

NOTE: Disposable items (i.e., Tyvek coveralls, inner gloves, and latex overboots) will be changed on a daily basis at a minimum. Dual respirator canisters will be changed as required.

Spray bottles or other designated equipment will be available in the decontamination area for wash down and cleaning of personnel, samples, and equipment.

Respirators, if utilized, will be decontaminated daily and taken from the drop area. Old cartridges will be marked to indicate length of usage or will be discarded in the contaminated trash container for disposal. When re-used, the masks will be reassembled and new cartridges installed, if necessary. Personnel will inspect their own respirators and readjust the straps for proper fit.

6.2. Small equipment decontamination

Small equipment will be protected from exposure as much as possible by wrapping, draping, masking, or otherwise covering the instruments with plastic (to the extent feasible) without hindering operations of the unit. For example, the PID meter can be placed in a clear plastic bag to allow reading the scale and operating the knobs. The PID sensor can be partially wrapped, keeping the sensor tip and discharge port clear.

Decontamination of small equipment will take place in the CRZ. Equipment will be taken from the drop area and the protective coverings removed and disposed of in appropriate containers. This equipment will be brushed or wiped with a disposable paper wipe.

The units can then be taken inside in a clean plastic tub, wiped off with damp disposable wipes, and dried. The units will be checked and recharged as necessary for the next day's operation, and then prepared with new protective coverings.

6.3. Heavy equipment decontamination

As appropriate, heavy equipment decontamination will take place at a predetermined on-Site location. Drilling rigs will be utilized during boring and well installation activities. They will be cleaned with high pressure water or steam and brushed to remove loose material. The person performing this activity will be required to use the level of PPE utilized by the personnel who operated the equipment being decontaminated. A decontamination pad will be set up at the decontamination location to allow collection and storage of contaminated decontamination fluids in DOT approved 55-gallon drums or a staged baker tank.

6.4. Disposal of contaminated materials

As appropriate, PPE, decontamination fluids (for both personnel and small equipment), and other disposable materials will be collected in the CRZ, properly containerized and stored at a designated on Site location. Decontamination fluids (*e.g.*, acetone used to decontaminate sampling equipment) will be collected into the on-site tank at a designated location. Disposable materials will be collected, and placed in drums at the designated on Site location. Disposable materials and fluids will be disposed of pursuant to and in accordance with Pennsylvania regulations.

7. Emergency response plan

The purpose of this section of the HASP is to address how site personnel will respond to emergencies. The types of potential emergencies that are addressed by this plan include:

- Fire
- Chemical exposures to site personnel
- Physical injuries to site personnel.

The release of chemicals to the environment which would impact the general public, property, or the environment is not anticipated during this project since the work will take place in areas which contain relatively low levels of contamination, if any. Normal decontamination procedures as specified in Section 6 will be followed to prevent the spread of contamination.

7.1. Emergency recognition and prevention

7.1.1. Fires

Fires are possible whenever flammable gases or vapors are present in proper concentrations and an ignition source is present. The construction equipment itself provides an ignition source.

7.1.2. Chemical exposures

Where possible, work shall be performed in such a manner that exposure to contaminants, if any, through skin or eye contact, inhalation or ingestion is minimized. Work practices that shall be followed to reduce chemical exposures include:

- PPE, as specified in Section 4, for the appropriate work activities and areas as defined by the HASC, shall be used by all personnel and subcontractor personnel. A formal revision to the HASP must be made by the HSM;

- Keep hands away from face during work activities; and,

- Minimize skin and eye contact with contaminants, if any.

Early recognition of chemical exposure symptoms is essential to the prevention of serious chemical exposure incidents. Symptoms of exposure to the types of compounds potentially present at the Site include one or more of the following: fatigue, weakness, eye, nose, throat irritation; headache; dizziness; nausea; vomiting; malaise; tremors; aggressive confusion; cyanosis (blue color to skin); anemia; and muscle spasms.

If a person experiences of these symptoms, or others, or recognizes the symptoms in a fellow worker, the person experiencing the symptoms will stop work and report the symptoms to the HASC. If the symptoms persist, the HASC will make arrangements to take the individual to a hospital for medical treatment. Work activities in the area where the person was exposed will be suspended until more is known about the incident. Incident reporting procedures as specified in Section 8.01 will be initiated.

7.1.3. Physical injury

Site personnel will constantly look for potential safety hazards such as holes or ditches; precariously positioned objects, such as drums or equipment that may fall; sharp objects, such as nails, metal shards, or broken glass; protruding objects at eye or head level; slippery surfaces; steep grades; uneven terrain or unstable surfaces, such as walls that may cave in or flooring that may give way. Site personnel should inform the HASC of potential hazards identified so that corrective mitigative action can be taken.

7.2. Emergency alerting procedures

The HASC will alert the appropriate work groups (and nearby residents, if any) when and if an emergency occurs relating to the Site investigation activities through the use of radios or by directly contacting the work group and nearby residents. The HASC and any isolated work group will carry radios if direct contact cannot be maintained. If radios fail, a single blast from an air horn will be used to signal workers to stop work.

7.3. Evacuation procedures and routes

Normally, personnel should evacuate through the Contamination Reduction Zone. Evacuation from the Contamination Reduction Zone will proceed in an upwind direction from the emergency. The HASC will establish an evacuation route from each sampling location prior to the start of work at that location.

7.4. Emergency medical treatment

The telephone numbers of local emergency services are given below (also see Exhibit 8).

Emergency Service	Telephone Number
Ambulance	911
Fire Department	911
Police Department	911
Paoli Memorial Hospital	(610) 648-1000
Poison Control Center	(800) 962-1253
USEPA National Response Center	(800) 438-2427

7.5. Emergency response personnel

The HASC will have the primary role in responding to on-site emergencies. Site personnel will contact the HASC in case of emergency. The HASC, or his designee, must be present during on-site work. If an emergency such as a fire, chemical exposure, or physical injury occurs, the HASC shall be immediately contacted. The HASC will have certification in First Aid. Site personnel will take direction from the HASC in cases of emergency response. If the HASC is not present, the Project Officer will respond to emergencies.

7.6. Decontamination procedures during an emergency

Decontamination of an injured or exposed worker shall be performed only if decontamination does not interfere with essential treatment.

If decontamination can be done; wash, rinse, and/or cut off protective clothing and equipment.

If decontamination cannot be done:

- Wrap the victim in blankets, plastic or rubber to reduce contamination of other personnel;

- Alert emergency and off-site medical personnel to potential contamination, and,

- HASC or other personnel familiar with the incident and Site contaminants shall accompany the victim to the hospital.

7.7. First aid procedures

On-site medical treatment or first aid may be administered by the HASC who will be certified in First Aid.

- Call an ambulance for transport to local hospital immediately. <u>This procedure should be followed even if there is no apparent serious injury</u>.

- Evacuate other on-site personnel to a safe place until the HASC determines that it is safe to resume work.

- Remove the injured or exposed person(s) from immediate danger.

- Decontaminate affected personnel, if necessary.

- Render first aid, if necessary.

Information Emergency First Aid Procedures is presented in Exhibit 9.

7.8. Directions to hospital (see attached map)

From the site, turn right onto Hood Road. Make a right onto eastbound Route 30 (Lincoln Highway). After approximately 1 mile, Paoli Memorial Hospital will be on the left.

8. General

8.1. Incident reporting

Incidents or accidents involving field personnel or subcontractors will require that a Hazardous Waste Incident Report be filed. Situations covered by this policy include but are not limited to fires, explosions, illnesses, injuries, and automobile accidents. These reports must be sent to the Project Manager, HSM and the HSS within 24 hours of the incident/accident. Worker's Compensation Insurance reports should be filed with the individual's employer within 48 hours of each accident or illness which results from work related activities and requires medical attention. See Exhibit 5 for an example of a Health and Safety Incident Report. The HASC will complete this form in case of an accident or incident.

8.2. Illumination and sanitation

It is anticipated that major work tasks will occur during daylight hours. The illumination requirements set forth by OSHA in 29 CFR 1910.120(m) will therefore be met.

The sanitation requirements regarding potable and non-potable waters, toilet facilities and washing facilities will be followed as set forth in 29 CFR 1910.120(n). Food handling and temporary sleeping quarters requirements are not applicable to this Site.

8.3. Compliance agreement

The Project Manager, HSS and HASC shall hold meetings with field personnel before work commences. During the meetings, personnel shall be provided with a copy of this HASP; the plan shall be reviewed and discussed and questions answered; and use, fit testing, and care of respirators documented. Signed Compliance Agreement Forms shall be collected by the HSS and filed. Individuals refusing to sign the form will not be allowed to work on the Site. Subcontractor personnel involved in field activities are required to comply with the provisions of their HASP. However, they are considered separately responsible for enforcement and/or modification of safety measures applied to their employees.

8.4. Health and safety report

A Health and Safety Report will be used to record entry and exit dates and times of all personnel and of project Site visitors; accidents, injuries, and illnesses; incidents of safety infractions by field personnel; air quality and personal exposure monitoring data; and other information related to safety matters. Accidents, illnesses, or other incidents are to be reported to the Project Manager and HSM. A copy of the Health and Safety Report for this project is presented in Exhibit 6.

8.5. Underground obstructions

Extreme caution should be exercised whenever the possibility of encountering underground utilities exists. Prior to commencement of intrusive activities, utilities will be notified as to the scope of work activities and markouts will be requested. No excavation will commence until utilities have been marked. Where underground utilities are encountered, the excavation will be terminated and a new location will be started.

8.6. Site safety meetings

During field operations, an initial site orientation meeting and daily safety meetings will be held by the HASC to review and plan specific health and safety aspects of scheduled work. Potential subjects to be discussed are presented below:

1. Preliminary
   - Medical clearances for participants;
   - Written HASP availability (copies to participants); and,
   - Personal protective equipment and decontamination equipment availability for checkout, demonstration and fit testing (if necessary).

2. Training topics
   - Delineation of on-site personnel responsibilities;
   - Review of HASP including:
     - types of hazards;
     - pathways of exposure;
     - levels of protection;
     - contamination avoidance;
     - confined space entry;
     - physical hazards;
     - decontamination;
     - emergency procedures; and,
     - specific on-site area/work tasks of concern.

   - Decontamination review including:
     - delineation of work zones; and,
     - set-up and dry run of equipment and maintenance.

   - Personnel protective clothing - use and dress out procedures;

   - Monitoring equipment review;

   - Questions and answers; and,

   - Signing an acknowledgment of having read the HASP.

9. Personnel assignments

9.1. Project personnel

RI Contractor personnel authorized to enter the work area and work on this project subject to compliance with the provisions of the HASP shall be listed here:

Project Officer:
Dana R. Pizarro, P.E.
(215) 628-9100 - ext. 209

Project Manager:
Thomas A. Nowlan, P.E.
(215) 628-9100 - ext. 213

On-Site Coordinator/On-Site HASC:
Michael S. Kozar, P.G. (or designee)
(215) 628-9100 - ext. 235

Corporate HSM and HSS:
Saunders Wilson, CIH
(315) 437-6100

Field Team Members:
Sam Crisino
Dennis J. Greene, P.E.
Douglas J. Grossman
Kenneth S. Jones
John Mason, P.G.
Karen Mattio
C. Lee McIlvaine
Eric T. Schleicher

9.2. HASP approvals

______________________________	______________
Corporate Officer	Date
______________________________	______________
Corporate Health and Safety Manager	Date
______________________________	______________
Project Manager	Date

9.3. Field team review

I, ______________ (print name), have received a copy of the Health and Safety Plan for the Bishop Tube Site. I have read the plan, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the Health and Safety Plan.

Signed:

______________________________	______________
Signature	Date

9.4. Medical data sheet

A Medical Data Sheet, such as that provided below, will be completed by all on-Site personnel and will be kept in the Support Zone during Site operations. It is in no way a substitute for the Medical Surveillance Program requirements consistent with the Health and Safety Program for Hazardous Waste Sites. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. If more information is required, the back of the sheet may be used.

Project: ______________________________

Name: ______________________________

Address: ______________________________

Home Phone: (____)______________________________

DOB: _______ Height: __________ Weight: _______

In case of emergency, contact: ______________________________

Address: ______________________________

Telephone: (____) ______________________________

Do you wear contact lenses? ( ) Yes ( ) No

Allergies: ______________________________

List of medications taken regularly: ______________________________

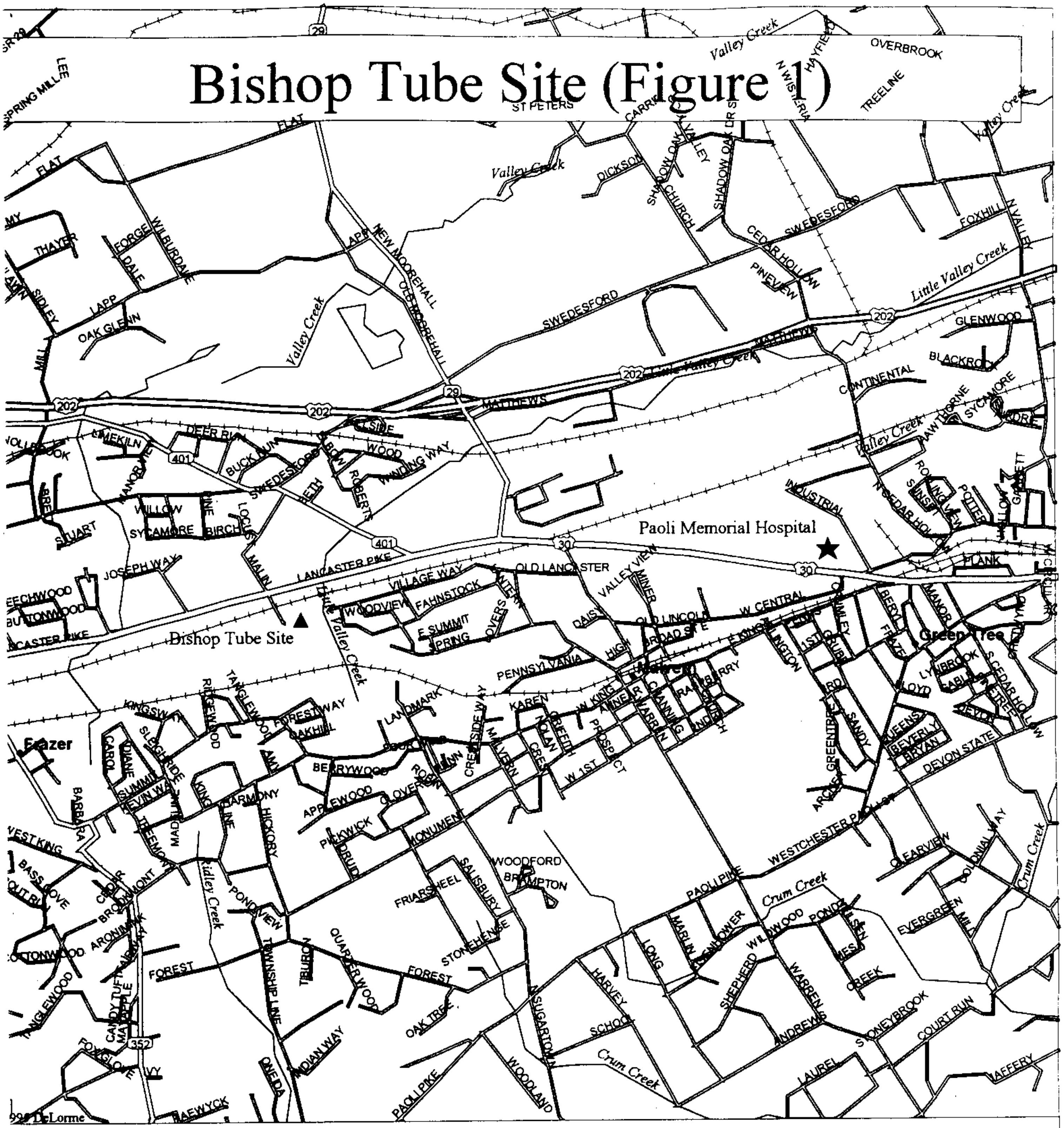
Sensitivities: ______________________________

Recent illness/exposure: ______________________________

Name of personal physician: ______________________________

Telephone: (____) ______________________________

Bishop Tube Site (Figure 1)



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)00 Feet
)00 Meters

Secondary SR, Road, Hwy Ramp — River, Canal
State Route
US Highway
Interstate/Limited Access
Railroad
Town, Small City
Population Center
Lake, Ocean, Large River

Exhibit 1 - Material safety data sheets

1,1,1-TRICHLOROETHANE

MSDS Number: T4914 — *Effective Date: 04/09/98*

1. Product Identification

Synonyms: Methyl chloroform; trichloroethane; chloroetene
CAS No.: 71-55-6
Molecular Weight: 133.40
Chemical Formula: CH_3CCl_3
Product Codes: 5381, 9435, 9436, 9437, W509, W510

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Methyl Chloroform	71-55-6	96 - 100%	Yes
Dioxane	123-91-1	< 3%	Yes
1,2-Epoxybutane	106-88-7	< 0.5%	Yes
Actual concentrations proprietary			

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER, KIDNEYS, AND CARDIOVASCULAR SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. POSSIBLE CANCER HAZARD. CONTAINS DIOXANE WHICH MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on

duration and level of exposure.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 1 - Slight
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
Inhalation of vapors will irritate the respiratory tract. Affects the central nervous system. Symptoms include headache, dizziness, weakness, nausea. Higher levels of exposure (> 5000 ppm) can cause irregular heart beat, kidney and liver damage, fall in blood pressure, unconsciousness and even death.
Ingestion:
Harmful if swallowed. Symptoms similar to inhalation will occur along with nausea, vomiting. Aspiration of material into the lungs can cause chemical pneumonitis which can be fatal. If aspirated, may be rapidly absorbed through the lungs and result in injury to other body systems.
Skin Contact:
Causes mild irritation and redness, especially on prolonged contact. Repeated contact may cause drying or flaking of the skin.
Eye Contact:
Liquids and vapors cause irritation. Symptoms include tearing, redness, stinging, swelling.
Chronic Exposure:
Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may affect the kidneys and liver. Dioxane is a suspected human carcinogen based on animal data.
Aggravation of Pre-existing Conditions:
Personnel with CNS, kidney, liver or heart disease may be more susceptible to the effects of this substance. Use of alcoholic beverages may aggravate symptoms.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician.
Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Autoignition temperature: 500C (932F)
Flammable limits in air % by volume:
lel: 7.0; uel: 16.0
Vapors in containers can explode if subjected to high energy source.
Dioxane has a flash point below 16C (60F).
Explosion:
Can react with strong caustic, such as potash to form a flammable or explosive material. Air/vapor mixtures may explode when heated. Vapors can flow along surfaces to distant ignition source and flash back. Sealed containers may rupture when heated.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Combustion by-products include phosgene and hydrogen chloride gases. Structural firefighters' clothing provides only limited protection to the combustion products of this material.

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! Do not use aluminum, magnesium or zinc metal for storage container. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Do not use aluminum equipment or storage containers. Contact with aluminum parts in a pressurized fluid system may cause violent reactions.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):
350 ppm (TWA) for trichloroethane
100 ppm (TWA) skin for dioxane
-ACGIH Threshold Limit Value (TLV):
350 ppm (TWA), 450 ppm (STEL) for trichloroethane
25 ppm (TWA) skin A3 - Animal Carcinogen for dioxane
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. This substance has questionable warning properties.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Viton is a recommended material for personal protective equipment.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Mild chloroform-like odor.
Solubility:
4,400 ppm in water @ 20C (68F)
Specific Gravity:
1.34 @ 20C/4C
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
74C (165F)
Melting Point:

-32C (-26F)
Vapor Density (Air=1):
4.63
Vapor Pressure (mm Hg):
100 @ 20C (68F)
Evaporation Rate (BuAc=1):
12.8

10. Stability and Reactivity

Stability:
Requires inhibitor content to prevent corrosion of metals. Slowly hydrolyzes in water to form hydrochloric and acetic acid.
Hazardous Decomposition Products:
May produce carbon monoxide, carbon dioxide, hydrogen chloride and phosgene when heated to decomposition. Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Hazardous polymerization can occur in contact with aluminum trichloride.
Incompatibilities:
Open flames, welding arcs, nitrogen tetroxide, oxygen, liquid oxygen, sodium, sodium hydroxide, and sodium-potassium alloy, strong alkalis, oxidizers, aluminum and other reactive metals.
Conditions to Avoid:
Insufficient inhibitor, incompatibles, heat, flame and ignition sources

11. Toxicological Information

Oral rat LD50: 9600 mg/kg; inhalation rat LC50: 18000 ppm/4H; investigated as a mutagen, tumorigen, reproductive effector; irritation eye rabbit, Standard Draize, 2mg/24H severe.

--------\Cancer Lists\--

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Methyl Chloroform (71-55-6)	No	No	3
Dioxane (123-91-1)	No	Yes	2B
1,2-Epoxybutane (106-88-7)	No	No	3

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this

material is expected to quickly evaporate. When released to water, this material is expected to quickly evaporate. This material is not expected to significantly bioaccumulate. When released into the air, this material may be removed from the atmosphere to a moderate extent by wet deposition. When released to the atmosphere, this material has an average global half-life of 6.0 - 6.9 years. When released into the air, this material may adversely affect the ozone layer.
Environmental Toxicity:
This material is expected to be slightly toxic to aquatic life. The LC50/96-hour values for fish are between 10 and 100 mg/l

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: 1,1,1-TRICHLOROETHANE
Hazard Class: 6.1
UN/NA: UN2831
Packing Group: III
Information reported for product/size: 20L

International (Air, I.C.A.O.)

Proper Shipping Name: 1,1,1-TRICHLOROETHANE
Hazard Class: 6.1
UN/NA: UN2831
Packing Group: III
Information reported for product/size: 20L

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Methyl Chloroform (71-55-6)	Yes	Yes	Yes	Yes
Dioxane (123-91-1)	Yes	Yes	Yes	Yes
1,2-Epoxybutane (106-88-7)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Methyl Chloroform (71-55-6)	Yes	Yes	No	Yes
Dioxane (123-91-1)	Yes	Yes	No	Yes
1,2-Epoxybutane (106-88-7)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\---------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Methyl Chloroform (71-55-6)	No	No	Yes	No
Dioxane (123-91-1)	No	No	Yes	No
1,2-Epoxybutane (106-88-7)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\---------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Methyl Chloroform (71-55-6)	1000	U226	No
Dioxane (123-91-1)	100	U108	No
1,2-Epoxybutane (106-88-7)	100	No	No

```
Chemical Weapons Convention:  No     TSCA 12(b):  Yes    CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Mixture / Liquid)
```

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 2[Z]
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **2** **Flammability:** **1** **Reactivity:** **0**
Label Hazard Warning:
WARNING! HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER, KIDNEYS, AND CARDIOVASCULAR SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. POSSIBLE CANCER HAZARD. CONTAINS DIOXANE WHICH MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Avoid breathing vapor.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid contact with eyes, skin and clothing.
Label First Aid:

If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 8.

Disclaimer:

****

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

CHEM SERVICE -- TRICHLOROETHENE, 0-664
MATERIAL SAFETY DATA SHEET
NSN: 681000N054678
Manufacturer's CAGE: 8Y898
Part No. Indicator: A
Part Number/Trade Name: TRICHLOROETHENE, 0-664

General Information

Company's Name: CHEM SERVICE INC
Company's P. O. Box: 3108
Company's City: WEST CHESTER
Company's State: PA
Company's Country: US
Company's Zip Code: 19381
Company's Emerg Ph #: 215-692-3026
Company's Info Ph #: 215-692-3026
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 07JAN93
Safety Data Review Date: 03NOV94
MSDS Serial Number: BVYRM
Hazard Characteristic Code: NK

Ingredients/Identity Information

Proprietary: NO
Ingredient: ETHYLENE, TRICHLORO-; (TRICHLOROETHYLENE) (SARA III)
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: KX4550000
CAS Number: 79-01-6
OSHA PEL: 100 PPM
ACGIH TLV: 50 PPM;100 PPM STEL

Proprietary: NO
Ingredient: SUPP DATA: BRTHG ADMIN ARTF RESPS.IF PATIENT IS IN CARD ARREST ADMIN CPR. CONTINUE LIFE SUPPORTING MEASURES UNTIL(ING 3)
Ingredient Sequence Number: 02
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Proprietary: NO
Ingredient: ING 2: MEDICAL ASSISTANCE HAS ARRIVED. INGESTION: CALL MD IMMEDIATELY (FP N).
Ingredient Sequence Number: 03
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Proprietary: NO
Ingredient: EYE PROTECTION: FULL LENGTH FACESHIELD (FP N).
Ingredient Sequence Number: 04
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: N/K (FP N)
ACGIH TLV: N/K (FP N)

Physical/Chemical Characteristics

Appearance And Odor: COLORLESS LIQUID.
Boiling Point: 189F,87C
Melting Point: -125F,-87C
Vapor Pressure (MM Hg/70 F): 58 @ 20C
Specific Gravity: 1.462

Solubility In Water: INSOLUBLE

Fire and Explosion Hazard Data

Flash Point: NON-FLAMMABLE
Lower Explosive Limit: 11%
Upper Explosive Limit: 41%
Extinguishing Media: CARBON DIOXIDE, DRY CHEMICAL POWDER OR SPRAY.
Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVED PRESSURE DEMAND SCBA AND FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE HCL AND PHOSGENE (FP N).

Reactivity Data

Stability: YES
Cond To Avoid (Stability): NONE SPECIFIED BY MANUFACTURER.
Materials To Avoid: STRONG BASES, STRONG OXIDIZING AGENTS.
Hazardous Decomp Products: DECOMPOSITION LIBERATES TOXIC FUMES. DECOMPOSITION PRODUCTS ARE CORROSIVE. HCL, PHOSGENE (FP N).
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT.

Health Hazard Data

LD50-LC50 Mixture: LD50 (ORAL,RAT): 4920 MG/KG.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: CONT LENSES SHOULD NOT BE WORN IN LAB. ALL CHEMS SHOULD BE CONSIDERED HAZ-AVOID DIRECT PHYS CONT! SUSPECTED CARCIN-MAY PRDCE CANCER. MAY BE HARMFUL IF ABSORB THRU SKIN. MAY BE HARMFUL IF INHALED. MAY BE HARMFUL IF SWALLOWED. LACHRYMATOR-CAUSES SEV EYE IRRIT. VAPS &/OR DIRECT EYE CONT CAN CAUSE SEV EYE (EFTS OF OVEREXP)
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT RELEVANT.
Signs/Symptoms Of Overexp: HLTH HAZ: BURNS. CAN CAUSE EYE IRRIT. CAN CAUSE SKIN IRRIT. CAN CAUSE SKIN BURNS. CAN CAUSE SEV SKIN BURNS. EXPOS CAN CAUSE LIVER DMG. EXPOS CAN CAUSE KIDNEY DMG. CAN CAUSE GI DISTURB. CAN BE IRRIT TO MUC MEMBS. PRLNGD EXPOS MAY CAUSE NAUS/HDCH/DIZZ &/OR EYE DMG.CAN CAUSE SENSIT BY SKIN CONT. CHLOROCARBON MATLS(SUPDAT)
Med Cond Aggravated By Exp: NONE SPECIFIED BY MANUFACTURER.
Emergency/First Aid Proc: AN ANTIDOTE IS SUBSTANCE INTENDED TO COUNTERACT EFT OF POIS. IT SHOULD BE ADMIN ONLY BY PHYS/TRAINED EMER PERS. MED ADVICE CAN BE OBTAINED FROM POIS CNTRL CNTR. EYE: FLUSH CONTINUOUSLY W/ WATER FOR AT LST 15-20 MINS. SKIN: FLUSH W/WATER FOR 15-20 MINS. IF NOT BURNS HAVE OCCURED-USE SOAP & WATER TO CLEANSE SKIN. INHAL: REMOVE PATIENT TO FRESH AIR. ADMIN OXYGEN IF PATIENT IS HAVING DFCLTY (SUPDAT)

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: EVACUATE AREA. WEAR APPROPRIATE OSHA REGULATED EQUIPMENT. VENTILATE AREA. ABSORB ON VERMICULITE OR SIMILAR MATERIAL. SWEEP UP AND PLACE IN AN APPROPRIATE CONTAINER. HOLD FOR DISPOSAL. WASH CONTAMINATED SURFACES TO REMOVE ANY RESIDUES.
Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.
Waste Disposal Method: BURN IN A CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS (FP N).
Precautions-Handling/Storing: AVOID CONTACT WITH SKIN, EYES AND CLOTHING. KEEP TIGHTLY CLOSED IN COOL DRY PLACE. STORE ONLY WITH COMPATIBLE CHEMICALS.
Other Precautions: NO SMOKING IN AREA OF USE. DO NOT USE IN GENERAL

VICINITY OF ARC WELDING, OPEN FLAMES OR HOT SURFACES. HEAT AND/OR UV RADIATION MAY CAUSE FORMATION OF HCL AND/OR PHOSGENE (FP N).

Control Measures

Respiratory Protection: WEAR NIOSH/MSHA APPROVED RESPIRATOR APPROPRIATE FOR EXPOSURE OF CONCERN (FP N).
Ventilation: CHEMICAL SHOULD BE HANDLED ONLY IN HOOD.
Protective Gloves: IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPRVD CHEM WORKERS GOGG & (ING 4)
Other Protective Equipment: USE APPROPRIATE OSHA/MSHA APPROVED SAFETY EQUIPMENT.EMER EYEWASH & DELUGE SHOWER WHICH MEET ANSI DESIGN STANDARDS(FP N).
Work Hygienic Practices: NONE SPECIFIED BY MANUFACTURER.
Suppl. Safety & Health Data: EFTS OF OVEREXP: HAVE PRDCED SENSIT OF MYOCARDIUM TO EPINEPHRINE IN LAB ANIMALS & COULD HAVE SIMILAR EFT IN HUMANS. ADRENOMIMETICS (E.G., EPINEPHRINE) MAY BE CONTRAINDICATED EXCEPT FOR LIFE-SUSTAINING USES IN HUMANS ACUTELY/CHRONICALLY EXPOS TO CHLOROCARBONS (FP N). FIRST AID PROC: BRTHG. IF PATIENT HAS STOPPED (ING 2)

Transportation Data

Disposal Data

Label Data

Label Required: YES
Technical Review Date: 03NOV94
Label Date: 26OCT94
Label Status: G
Common Name: TRICHLOROETHENE, 0-664
Chronic Hazard: YES
Signal Word: DANGER!
Acute Health Hazard-Moderate: X
Contact Hazard-Severe: X
Fire Hazard-None: X
Reactivity Hazard-None: X
Special Hazard Precautions: ACUTE: INHALATION OF VAPORS MAY CONTRIBUTE TO THE OCCURRENCE OF IRREGULAR HEARTBEAT (FP N). MAY BE HARMFUL IF ABSORB THRU SEVERE BURNS/IRRITATION MAY CAUSE LIVER/KIDNEY DAMAGE, GASTROINTESTINAL DISTURBANCE. MAY CAUSE MUCOUS MEMBRANE IRRITATION. CHRONIC: NAUSEA, HEADACHE, DIZZINESS AND/OR EYE DAMAGE.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: CHEM SERVICE INC
Label P.O. Box: 3108
Label City: WEST CHESTER
Label State: PA
Label Zip Code: 19381
Label Country: US
Label Emergency Number: 215-692-3026

International Chemical Safety Cards

VINYL CHLORIDE

ICSC: 0082

VINYL CHLORIDE
Chloroethene
Chloroethylene
VCM
(cylinder)
$C_2H_3Cl/H_2C{=}CHCl$
Molecular mass: 62.5

CAS # 75-01-4
RTECS # KU9625000
ICSC # 0082
UN # 1086 (inhibited)
EC # 602-023-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
[illegible]	Extremely flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out; in other cases extinguish with powder, carbon dioxide.
[illegible]	Gas/air mixtures are explosive. Vinyl chloride monomer vapours are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in blockage of vents.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep cylinder cool by spraying with water. Combat fire from a sheltered position.
[illegible]		AVOID ALL CONTACT!	
[illegible]	Dizziness. Drowsiness. Headache. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
[illegible]	ON CONTACT WITH LIQUID: FROSTBITE.	Protective gloves. Cold-insulating gloves. Protective clothing.	ON FROSTBITE: rinse with plenty of water, do NOT remove clothes.
[illegible]	Redness. Pain.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
[illegible]		Do not eat, drink, or smoke during work. Wash hands before eating.	

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Ventilation (extra personal protection: complete protective clothing including self-contained breathing apparatus).	Fireproof. Separated from incompatible materials (see Chemical Danger). Cool.	F symbol T symbol R: 45-13 S: 53-9-16-44 Note: D UN Hazard Class: 2.1

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0082

International Chemical Safety Cards

VINYL CHLORIDE

ICSC: 0082

PHYSICAL STATE; APPEARANCE:
COLOURLESS COMPRESSED LIQUEFIED GAS, WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The gas is heavier than air, and may travel along the ground; distant ignition possible.

CHEMICAL DANGERS:
The substance can under specific circumstances form peroxides, initiating explosive polymerization. The substance will polymerize readily due to heating and under the influence of air, light, and on contact with a catalyst, strong oxidizing agents and metals such as copper and aluminium, with fire or explosion hazard. The substance decomposes on burning producing toxic and corrosive fumes (hydrogen chloride and phosgene).

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: 5 ppm; 13 mg/m^3 (ACGIH 1993-1994).

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation.

INHALATION RISK:
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes. The liquid may cause frostbite. The substance may cause effects on the central nervous system. Exposure could cause lowering of consciousness. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The substance may have effects on the liver, blood vessels and connective tissue. This substance is carcinogenic to humans. May cause heritable genetic damage in humans.

Boiling point: -13°C
Melting point: -154°C
Relative density (water = 1): 0.9
Solubility in water: none
Relative vapour density (air = 1): 2.2

Flash point: -78°C c.c.°C
Auto-ignition temperature: 472°C
Explosive limits, vol% in air: 3.6-33
Octanol/water partition coefficient as log Pow: 0.6

NOTES

According to ACGIH this substance belongs to Group A1 indicating confirmed human carcinogen. Contains inhibitors (e.g. phenol). Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding.

Transport Emergency Card: TEC (R)-150
NFPA Code: H 2; F 4; R 2;

NFPA Code: H 2; F 4; R 2;

ADDITIONAL INFORMATION

ICSC: 0082	**VINYL CHLORIDE**

IMPORTANT LEGAL NOTICE:	Neither the CEC or the IPCS nor any person acting on behalf of the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use.

Exhibit 2 - Safety guidelines for drilling

Be careful when lifting heavy objects. Before lifting a relatively heavy object, approach the object by bending at the knees, keeping your back vertical and unarched while obtaining a firm footing. Grasp the object firmly with both hands and stand slowly and squarely while keeping your back vertical and unarched. In other words, perform the lifting with the muscles in your legs, not the muscles in your lower back.

Drilling operations should be suspended during an electrical storm.

The minimum number of personnel necessary to achieve the objectives shall be within 25 feet of the drilling or sampling activity. Back-up personnel should remain at least 25 feet away from the drilling or sampling activity, where practical.

Hard hats and steel toe boots are to be worn by all personnel in the vicinity of the drilling activities. Drilling personnel should not wear loose-fitting or bagging clothing which may be awkward or get caught on equipment. Jewelry, including rings and necklaces, should not be worn around electrical wires or rotating equipment.

Safety guidelines for drilling

Drill rig maintenance and safety is the responsibility of the drilling subcontractor. The following information is provided as a general guideline for OB&G personnel for safe drilling practices at the Site.

Off-Road Movement of Drill Rigs The following safety guidelines related to off-road movement:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, slumps, gulleys, ruts and similar obstacles;
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground;
- Discharge all passengers before moving a drill rig on rough or hilly terrain;
- Engage the front axle (for 4x4, 6x6, etc., vehicles or carriers) when traveling off highway on hilly terrain;
- Use caution when traveling side-hill. Conservatively evaluate side-hill capability of drill rigs, because the arbitrary addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill;
- Attempt to cross obstacles such as small logs and small erosion channel or ditches squarely, not at an angle;
- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is close;
- After the drill rig has been moved to a new drilling site, set all brakes and/or locks. When grades are steep, block the wheels;
- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position; and;
- Tie down loads on the drill rig and support trucks during transport.

Overhead and Buried Utilities The use of a drill rig near electrical power lines and other utilities requires that special precautions be taken by both supervisors and members of the exploration crew. Electricity can shock; it can burn; and it can cause death.

Overhead and buried utilities should be located, noted and emphasized on all boring location plans and boring assignment sheets.

Before raising the drill rig mast (derrick) on a site in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the drill rig to the nearest power line will be when the mast is raised and/or being raised. Do not raise the mast or operate the drill rig if this distance is less than 20 ft. In general, the distance between the overhead power line and the boom should be no less than the height of the boom.

Keep in mind that both hoist and overhead power lines can be moved toward each other by the wind.

Drilling personnel should double-check any site underground electrical and piping drawings prior to initiating drilling. If an obstruction is encountered during drilling, proceed with extreme caution until the possibility of an exposed electrical line or combustible product pipeline is excluded.

Clearing The Work Area Prior to drilling, adequate site cleaning and leveling should be performed to accommodate the drill rig and supplies and provide a safe working area. Drilling should not be commenced when tree limbs, protruding objects, unstable ground or obstructions or debris may cause unsafe tool handling conditions and/or limited, awkward work spaces. An area clear of obstructions or debris should be maintained 180 degrees around the drilling or sampling activities, where practical.

Note: In coordination with the drilling crew, the Site Safety Officer will review the precautions taken to insure that the drill rig is leveled and stabilized.

Housekeeping On and Around the Drill Rig The first requirement for safe field operations is that the drilling crew safety supervisor understand and fulfills the responsibility for maintenance and "housekeeping" on and around the drill rig.

Suitable storage locations should be provided for all tools, materials and supplies so that they can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor, without creating tripping hazards, and without protruding at eye or head level.

Avoid storing or transporting tools, materials or supplies within or on the mast (derrick) of the drill rig.

Pipe, drill rods, bit casings, augers and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling or sliding.

Penetration or other driving hammers should be placed at a safe location on the ground or secured to the drill rig to prevent movement when not in use.

Work areas, platforms, walkways, scaffolding and other accessways should be kept free of materials, obstructions and substances such as oil, grease and/or ice that could cause a surface to become slick or otherwise hazardous.

Keep all controls, control linkages, warning and operation lights and lenses free of oil, grease and/or ice.

Do not store gasoline in any portable container other than a non-sparking, red container with a flame arrester in the fill spout and having the word "gasoline" easily visible.

Welding gas cylinders should be stored in an upright position to avoid gas leaks.

Safe Use of Hand Tools There is an almost infinite number of hand tools that can be used on or around a drill rig. "Use the tool for its intended purpose" is the most important rule. The following are a few specific and some general suggestions which apply to safe use of several hand tools that are often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or get rid of it.

- When using a hammer, any kind of hammer for any purpose, wear safety glasses and require all others near you to wear safety glasses.

- When using a chisel, any kind of chisel, for any purpose, wear safety glasses and require all others around you to wear safety glasses.

- Keep all tools cleaned and stored when not in use.

- Replace hook and heel jaw when they become visibly worn.

- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be smashed between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

Safe Use of Wire Line Hoists, Wire Rope, and Hoisting Hardware

The use of wire line hoists, wire rope, and hoisting hardware should be as stipulated by the American Iron and Steel Institute's Wire Rope Users Manual.

All wire ropes and fittings should be visually inspected during and thoroughly inspected at least once a week for: abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper weaving, jamming, crushing, bird caging, kinking, core protrusion and damage to lifting hardware and any other feature that would lead to failure. Wire ropes should be replaced when inspection indicates excessive damage according to the wire rope users manual.

If a ball-bearing type hoisting swivel is used to hoist drill rods, swivel bearings should be inspected and lubricated daily to assure that the swivel freely rotates under load.

If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device; do not hoist more than 1 ft (0.3m) of the drill rod column above the top of the mast (derrick), do not hoist a rod column with loose tool joints; and do not make up, tighten or loosen tool joints while the rod column is being supported by a slipping device. If drill rods should slip back into the borehole, do not attempt to brake the fall of the rods with your hands.

Most sheaves on drill rigs are stationary with a single part line. The number of parts of line should never be increased without first consulting with the manufacturer of the drill rig. Wire ropes must be properly matched with each sheave.

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware.

Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling). Do not use tool handling hoists to pull on objects away from the drill rig; however, drills may be moved using the main hoist as the wire rope is pulled through proper sheaves according to the manufacturer's recommendations.

When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill. Do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanism of the drill.

When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle or drill rig carrier. Stay as far as possible away from the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.

Minimize shock loading of a wire rope - apply loads smoothly and steadily.

- Protect wire rope from sharp corners or edges.
- Replace faulty guides and rollers.
- Replace worn sheaves or worn sheave bearings.
- Replace damaged safety latches on safety hooks before using.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Clutches and brakes of hoists should be periodically inspected and tested.
- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.
- Always wear gloves when handling wire ropes.
- Do not guide wire ropes on hoist drums with your hands.
- Following the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.
- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public and/or property are created.
- Never leave a load suspended in the air when the hoist is unattended.
- Keep your hands away from hoists, wire rope, hoisting hooks, sheaves and pinch points as slack is being taken up and when the load is being hoisted.
- Never hoist the load over the head, body or feet of any personnel.

Safe Use of Augers The following general procedures should be used when advancing a boring with continuous flight or hollow-stem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear and the engine running at low RPM.

- The operator and tool handler should establish a system of responsibility for the series of various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.

- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench or any other tools during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground or other hard surfaces such as the drill rig platform.

- Never allow feet to get under the auger section that is being hoisted.

- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatever.

- Never place your hands between the drill rig and an auger, even when attempting to free a damaged or bound Shelby tube from the auger.

- Never use your hands or feet to move cuttings away from the auger.

- Augers should be cleaned only when the drill rig is in neutral and the augers are stopped from rotating.

Safety During Rotary and Core Drilling Rotary drilling tools should be safety checked prior to drilling.

- Water swivels and hoisting plugs should be lubricated and checked for "frozen" bearings before use.

- Drill rod chuck jaws should be checked periodically and replaced when necessary.

- The capacities of hoists and sheaves should be checked against the anticipated weight to the drill rod string plus other expected hoisting loads. All cables should be inspected daily.

Special precautions that should be taken to ensure safe rotary or core drilling involve chucking, joint break, hoisting and lowering of drill rods.

- Drill rods should not be braked during lowering into the hole with drill rod chuck jaws.

- Drill rods should not be held or lowered into the hole with pipe wrenches.

- If a string of drill rods are accidently or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.

- In the vent of a plugged bit or other circulation blockage, the high pressure in the piping and hose between the pump and the obstruction should be relieved or bled down before breaking the first tool joint.

- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber wiper or other suitable rod wiper. Do not use your hands to clean drilling fluids from drill rods.

- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit should be equipped with a rough surface, and fitted cover panels of adequate strength to hold drill rig personnel.

- Drill rods should not be lifted or leaned unsecured against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down.

- All hydraulic lines should be periodically inspected for integrity and replaced as needed.

Start-Up All drill rig personnel and visitors should be instructed to "stand clear" of the drill rig immediately prior to and during starting of an engine.

Make sure all gear boxes are in neutral; all hoist levers are disengaged; all hydraulic levers are in the correct non-actuating positions; and the cathead rope is not on the cathead before starting a drill rig engine.

General Safety During Drilling Operations Safety requires the attention and cooperation of every worker and site visitor.

Do not drive the drill rig from hole to hole with the mast (derrick) in the raised position.

Before raising the mast (derrick) look up to check for overhead obstructions. (Refer to previous Section on overhead and buried utilities).

Before raising the mast (derrick), all drill rig personnel and visitors (with exception of the operator) should be cleared from the areas immediately to the rear and the sides of the mast. All drill rig personnel and visitors should be informed that the mast is being raised prior to raising it.

Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must be leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig should be releveled if it settles after initial set up. Lower the mast (derrick) only when leveling jacks are down and do not raise the leveling jack pads until the mast (derrick) is lowered completely.

Before staring drilling operations, secure and/or lock the mast (derrick), if required, according to the drill manufacturer's recommendations.

The operator of a drill rig should only operate a drill rig from the position of the controls. The operator should shut down the drill engine before leaving the vicinity of the drill rig.

Consuming alcoholic beverages or other depressants or chemical stimulants prior to starting work on a drill rig or while on the job is strictly prohibited.

Watch for slippery ground when mounting and dismounting from the platform.

All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. All open boreholes should be covered, protected or backfilled adequately and according to local or state regulations on completion of the drilling project.

"Horsing around" within the vicinity of the drill rig and tool and supply storage areas should never be allowed, even when the drill rig is shut down.

Be careful when lifting heavy objects. Before lifting a relatively heavy object, approach the object by bending at the knees, keeping your back vertical and unarched while obtaining a firm footing. Grasp the object firmly with both hands and stand slowly and squarely while keeping your back vertical and unarched. In other words, perform the lifting with the muscles in your legs, not the muscles in your lower back.

Drilling operations should be suspended during an electrical storm.

The minimum number of personnel necessary to achieve the objectives shall be within 25 feet of the drilling or sampling activity. Back-up personnel should remain at least 25 feet away from the drilling or sampling activity, where practical.

Hard hats and steel toe boots are to be worn by all personnel in the vicinity of the drilling activities. Drilling personnel should not wear loose-fitting or bagging clothing which may be awkward or get caught on equipment. Jewelry, including rings and necklaces, should not be worn around electrical wires or rotating equipment.

Exhibit 3 - Heat stress prevention plan

Heat stress prevention plan

Due to the increase in ambient air temperatures and the effects of protective outer wear decreasing body ventilation, there exists an increase in the potential for injury, specifically, heat casualties. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim and the prevention of heat stress casualties.

Identification and Treatment

1. Heat Exhaustion
   a. **Symptoms:** Usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, the skin clammy, and perspiration may be profuse. The pulse is weak and fast, breathing is shallow. The victim may faint unless the victim lies down. The symptoms may pass, but can remain and death could occur.

   b. **First Aid:** Immediately remove the victim to the Decontamination Zone or to a shady or cool area with good air circulation. Remove all protective outer wear. Call a physician. Treat the victim for shock. (Make the victim lie down, elevate feet 6-12 inches and keep the victim warm, but loosen all clothing.) If the victim is conscious, it may be helpful to administer sips of a salt water solution (1 teaspoon of salt to 1 glass of water). Transport victim to a medical facility as soon as possible.

2. Heat Stroke
   a. **Symptoms:** This is the most serious of heat casualties due to the fact that the body excessively overheats. Body temperatures often are between 107° - 110°F. First there is often pain in the head, dizziness, nausea, oppression, and the skin is dry, red and hot. Unconsciousness follows quickly and death is imminent if exposure continues.

   b. **First Aid:** Immediately evacuate the victim to a cool and shady area in the Decontamination Zone. Remove all protective outer wear and all personal clothing. Lay victim on back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels, ice bags, etc., to the head. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place the victim in a tub of cool water. The main objective is to cool the victim without chilling. Give no stimulants. Transport the victim to a medical facility as soon as possible.

Prevention of Heat Stress

1. One of the major causes of heat casualties is the depletion of body fluids. At the Site there will be plenty of fluids available. Personnel should replace water and salt lost from sweating. Salts can be replaced by drinking a commercial mix of electrolytes and nutrients such as Gatorade. If Gatorade is consumed for extended periods of time, it should be mixed at 50 percent of normal strength.

2. A work schedule should be established so that the majority of the work day will be during the morning hours before ambient air temperature levels reach their highs.

3. A work/rest guideline will be implemented for personnel required to wear Level B protection. This guideline is as follows:

Ambient Temperatures	Maximum Wearing Time
Above 90°F	½ hour
80°-90°F	1 hour
70°-80°F	2 hours
60°-70°F	3 hours
60°F	4 hours

   A sufficient period will be allowed for personnel to "cool down." This may require shifts of workers during operations. No work is to take place under Level B protection in this project without approval by Project Officer.

4. Work time may be increased by use of a body cooling suit such as a steel vest cooling system with ice pack thermostrips.

Heat Stress Monitoring For monitoring the body's recuperative ability to excess heat, one or more of the following techniques should be used as a screening mechanism. Monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70 degrees Fahrenheit or above. Frequency of monitoring should increase as the ambient temperature increases or if slow recovery rates are indicated. When temperatures exceed 80 degrees Fahrenheit, workers must be monitored for heat stress after every work period.

- Heart rate ("HR") should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle should be shortened by 33%.

- Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature ("OT") at the beginning of the rest period should not exceed 99 degree Fahrenheit. If it does, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stays the same. However, if the OT exceeds 99.7 degrees Fahrenheit at the beginning of the next period, the following work cycle should be further shortened by 33%. OT should be measured again at the end of the rest period to make sure that it has dropped below 99 degree Fahrenheit.

- Body water loss ("BWL") due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing worn should be similar at both weighings; preferably the worker should be nude. BWL should not exceed 1.596 of the total body weight. If it does, workers should be instructed to increase their daily intake of fluids by the weight loss.

Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in sweat as well.

Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

Exhibit 4 - Ticks and tick-borne diseases

Ticks and tick-borne diseases

Field personnel should be aware of an increased occurrence of tick-borne disease in the United States. In the northeast, the most likely carriers are the white-footed mouse and the white-tailed deer. These animals are most prevalent in areas where suburban environments abut open fields or woodlands. Although exposure is increased in these areas, other carriers, such as dogs and horses, can be found in a variety of environments.

All field personnel should take proper precautions to limit exposure to ticks and tick-borne diseases. These include:

- Cinching and taping clothing at the ankles and wrists, especially the ankles. Ticks lie low on grass blades and shrubs. They encounter your feet, ankles or lower legs and then crawl upward;

- Wear light-colored clothing to facilitate spotting the ticks, and check your clothing periodically. Be especially careful in terrain with tall grass, bushes or woods;

- Use a tick repellent on skin or clothing. Always read the labels before using. Clothing repellents should never be used on the skin;

- Recognize the signs of a bite or an infection. It takes several hours for a tick to attach and feed; removing it promptly lessens the chance of being infected; and,

- Seal field clothes in plastic bags until cleaned. Do not take them into the house or office as a tick(s) may be attached.

Pregnant women should be particularly careful since the effects of the most common tick-borne disease in the northeast, Lyme disease, upon the fetus is unknown.

Lyme disease is caused by the spirochete bacterium *Borrelia borgdorferi*, which is carried on *Ixodes dammini* commonly known as the deer tick. The tick is about the size of a pin head or a freckle, hence one recommendation is to look for a moving freckle, since the tick may generally pass unnoticed.

If a tick is discovered on the skin, it is important to remove the entire insect as soon as possible. The most effective method is to grasp the tick as close as possible to the mouth with tweezers or thin, curved forceps. Then, without jerking, pull it upward steadily (a small amount of skin may be removed in the process).

After removing the tick, disinfect the bite with rubbing alcohol plus Adolph's Meat Tenderizer (meat protein, not artificial) or povidone iodine (Betadine). Don't handle the tick, since spirochetes could enter the body through breaks in the skin. Dispose of it in alcohol or flush it down the drain. Check the bite occasionally for at least three weeks to see if a rash forms. If it does, you've been infected and should seek medical treatment promptly.

The rash generally appears at the bite location from two days to two weeks after the bite. It usually starts as a small red spot that expands as the spirochetes spread beyond the bite. Most commonly, the rash develops into a reddish circle or oval about two to three inches in diameter. It fades with or without treatment after a few weeks.

Much larger rashes - anywhere from 6 to 20 inches in diameters - may also occur, especially on the back. Despite their size, large rashes may be easy to miss because they're often very faint.

Other variants include a rash with a red perimeter and a clear center and the so-called bull's-eye rash, which consists of several concentric red rings. Rashes may vary in shape, depending on where they occur on the body. Frequent sites are the thigh, groin, and armpits. People often develop a rash in more than one place.

Early symptoms may include profound fatigue, a stiff neck, and flu-like symptoms such as headache, chills, fever, and muscle aches. Since tick bites don't always produce a rash, those symptoms alone may warrant a medical check for possible Lyme infection - especially if bites occur in summer and work is being done in an area in which Lyme disease is common.

Without treatment, the spirochetes usually multiply and the disease progressively worsens. The second stage, occurring within weeks to months of the bite, may affect the heart or nervous system. The third stage is the chronic arthritic stage, which begins up to a year or more after the bite.

Exhibit 5 - Health and safety incident report form

HEALTH AND SAFETY INCIDENT REPORT

Project Name ______________________________

Project Number ______________________________

Date of Incident ______________________________

Time of Incident ______________________________

Location ______________________________

TYPE OF INCIDENT (Check all applicable items)

____ Illness ____ Injury ____ Fire, explosion, flash ____ Vehicular accident

____ Property Damage ____ Unexpected exposure ____ Health and Safety Infraction

____ Other (describe)______________________________

PROJECT NAME ____________________ LOCATION ____________________

Description of Incident (Describe what happened and possible cause, identify individuals involved, witnesses, and their affiliations, and describe emergency or corrective action taken).

____

____

____

____

____

Reporter: ____________________ ____________________ ____________

Print Name Signature Date

Reporter must deliver this report to the Operating Unit Health and Safety Officer within 24-hours of the reported incident for medical treatment cases and within five days for other incidents.

Reviewed by: ______________________________ ____________

Operating Unit Health and Safety Officer Date

Distribution:

_______ Corporate Health and Safety Administrator
_______ Corporate Health and Safety Officer
_______ Project Manager
_______ Personnel Office (Medical Treatment Cases Only)

Exhibit 6 -Health and safety report

HEALTH AND SAFETY REPORT

HSO: ______________________________ Date: ________________

Weather: ____

OBG Personnel Present: ______________________________________
(include times) ______________________________________
____

Work Activities: ______________________________________
____
____
____
____

Level of Protection: ______________________________________
____
____

Summary of Ambient Measurement*:	_______ ppm (HNU PID)	_______ PPM (CGI/H_2S)
	_______ ppm (Foxboro OVA)	_______ ppm ___ (Drager)
	_______ % O_2 (CGI/02)	_______ ppm ___ (Drager)
	_______ % LEL (CGI/% LEL)	_______ ppm ___ (Drager)
Summary of Environmental Monitoring in Breathing Zone*:	_______ ppm (HNU PID)	_______ PPM (CGI/H_2S)
	_______ ppm (Foxboro OVA)	_______ ppm ___ (Drager)
	_______ % O_2 (CGI/02)	_______ ppm ___ (Drager)
	_______ % LEL (CGI/% LEL)	_______ ppm ___ (Drager)

Notes, Incidents and Comments: ______________________________________
____
____
____
____

* Detailed record of measurements contained in Inspector's Field Inspection Reports.

Exhibit 7 -Required personal protective equipment

Required personal protective equipment

Level D Personal Protective Equipment

- Hard hat (if overhead hazard exists)
- Safety glasses
- ANSI-approved Steel-toes and steel shank work boots
- Nitrile - butadiene rubber outer gloves (to be worn over surgical gloves)(1)
- Latex surgical gloves(2)
- Regular Tyvek coveralls(1)
- Rubber overboots or disposable "booties"(1)

(1) Optional, at discretion of HSO.
(2) To be worn during drilling, excavating and sampling activities.

Modified Level D Personal Protective Equipment

- Hard hat (if overhead hazard exists)
- Safety glasses or goggles
- ANSI-approved Steel-toes and steel shank work boots
- Nitrile - butadiene rubber outer gloves (to be worn over surgical gloves)
- Latex surgical gloves
- Saranex impregnated Tyvek coveralls (taped at cuffs)
- Rubber overboots or disposable "booties"

Level C Personal Protective Equipment

- Hard hat
- Fullface MSA respirator with GMC-H combination cartridges
- ANSI-approved Steel-toes and steel shank work boots
- Nitrile - butadiene rubber outer gloves (to be worn over surgical gloves)(1)
- Latex surgical gloves
- Rubber overboots or disposable "booties"
- Low profile "denim colored" regular Tyvek coveralls or Saranex impregnated Tyvek coveralls(2) (taped at cuffs)(1)

(1) Optional, at discretion of HSO.
(2) Choice at discretion of HSO.

Exhibit 8 - Emergency telephone numbers and directions to hospital

Emergency telephone numbers and directions to hospital

This list of emergency services must either be posted on Site or carried by field personnel:

Emergency Service	Telephone Number
Ambulance	911
Fire Department	911
Police Department	911
Paoli Memorial Hospital	(610) 648-1000
Poison Control Center	(800) 962-1253
USEPA National Response Center	(800) 438-2427

DIRECTIONS TO IRVINGTON GENERAL HOSPITAL

Paoli Memorial Hospital: From site, turn right onto Hood Road. Make a right onto eastbound Route 30 (Lincoln Highway). After approximately 1 mile, Paoli Memorial Hospital will be on the left.

Exhibit 9 - Emergency first aid procedures

Emergency first aid procedures

If an employee working in a contaminated area is physically injured, Red Cross first aid procedures will be followed. Depending on the severity of the injury, emergency medical response may be sought. If the employee can be moved, they will be taken to the work area (on a stretcher, if needed) where contaminated clothing will be removed (if possible), emergency first aid administered, and transportation to local emergency medical facility awaited.

If the injury to the worker is chemical in nature (e.g., overexposure), the following first aid procedures are to be instituted as soon as possible:

a. Eye Exposure - If contaminated solid or liquid gets into the eyes, wash eyes immediately at the emergency eyewash stations using large amounts of water and lifting the lower and upper lids occasionally. Obtain medical attention immediately. (Contact lenses are not permitted in the Exclusion Areas.)

b. Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash contaminated skin using soap or mild detergent and water. If solids or liquid penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately if symptoms warrant.

c. Breathing - If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

d. Swallowing - If contaminated solid or liquid has been swallowed and the person is conscious, feed the person large quantities of salt water immediately and induce vomiting (unless the person is unconscious). Obtain medical attention immediately.

<u>First Aid Procedures</u>

- Remove the injured or exposed person(s) from immediate danger.

- Render first aid if necessary, and decontaminated affected person, if possible.

- Call an ambulance for transport to local hospital immediately. <u>This procedure should be followed even if their is no apparent serious injury</u>. Emergency numbers are in Attachment B8.

- Evacuate other personnel on-Site to a safe place until the HSO determines that it is safe to resume work.